



**IMPORTANCE OF BIODIVERSITY
AND ECOSYSTEMS IN ECONOMIC
GROWTH AND EQUITY IN LATIN
AMERICA AND THE CARIBBEAN:
AN ECONOMIC VALUATION
OF ECOSYSTEMS**

**LATIN AMERICA
AND THE CARIBBEAN
A BIODIVERSITY SUPER POWER**

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Part of the UNDP Initiative by the
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**LATIN AMERICA
AND THE CARIBBEAN
A BIODIVERSITY SUPER POWER**

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PREFACE

UNDP's Regional Programme for Latin America and the Caribbean, in partnership with UNEP, ECLAC, UNCTAD and the Secretariat of the Convention on Biological Diversity, present this report *The Importance of Biodiversity and Ecosystems in Economic Growth and Equity in Latin America and Caribbean: A Regional Economic Valuation of Ecosystems* to generate a dialogue within the region on the need and competitive advantages of incorporating the conservation and sustainable management of biodiversity and the ecosystem services into development plans, emphasising the role both play in the development and equity. Biodiversity is intrinsically linked to the culture of our region- its conservation and sustainable management is a must for the region.

We are grateful to members of the Commission of Biodiversity, Ecosystems, Finance and Development for its guidance, and to the Technical team that prepared the report, as well as the numerous experts that provided feedback and reviews. Extensive stakeholder consultations were carried out throughout the region with representatives of the public sector, private sector, academia, and civil society, to pinpoint precisely the issues most important to them, and the experiences that best illustrate the fact that with the right policies in place, biodiversity and ecosystem services can be used to generate sustainable economic growth. Existing examples of and opportunities for further livelihood and employment generation are many and varied, showing a wide range of promising market opportunities for green products and services.

The sustainable use of biodiversity and ecosystem services is not only the key to economic development, but is also of vital importance to human development, if used wisely. The region's natural capital provides the primary social safety net for rural populations across the region and is one of the few factors limiting malnutrition and large-scale urban migration. If degradation continues, many of the region's most vulnerable peoples, in particular indigenous communities, will be without a source of food, income, or habitat in which they have built their lives and traditions over the centuries.

Through the equitable use of traditional knowledge of biodiversity's uses, valuation of biodiversity and ecosystem services, education and advocacy for the recognition of its true value, as well as technological innovation to optimise and capitalise on its sustainable use, there is much work to be done beyond this Initiative.

Now is the time to question the "business as usual" practices that endanger the future of our natural heritage and capital, and take decisive action toward sustainable management of our ecosystems and biodiversity as an engine of economic growth and social equity. Nothing less than the future of the region's economic growth and wellbeing of its people are at stake. I urge policymakers and all stakeholders to heed the message of this timely report. If used sustainably, the region's natural capital can elevate the region to sustainable superpower.



Heraldo Munoz,
Regional Director RBLAC

PREFACE

UNDP's Environment and Energy Group is pleased to publish this Report which will be a cornerstone for future approaches and policy dialogue on the economics and management of ecosystem services. The Report highlights the economic contribution of biodiversity conservation and ecosystem services to development and equity in Latin America and the Caribbean. It is to serve as an economic tool for decision makers so that ecosystem services are considered in sectoral and national planning. Ecosystem services are used as proxies for biodiversity since they are easier to connect with sectoral outputs.

The Report's approach is to analyze sectoral outputs at a micro-economic level, comparing costs and benefits between different types of natural resource production practices—those that take account of ecosystem services and those that do not. The Report has undertaken this analysis for several important sectors—agriculture, fisheries, forestry, tourism—as well as the cross-cutting protected areas and water services. Findings from the region are used to highlight costs of conventional practices and market opportunities for more sustainable practices, for example through certification labels. Findings show, on the one hand, that there are economic costs of degrading ecosystem services, which do not show up in economic indicators and, on the other hand, that there is an increased opportunity to generate income from conserving and marketing ecosystem services.

The findings further indicate that changes in the global economy, combined with climate change, social change and increasing scarcity of ecosystem services is changing the cost-benefit analysis so that the conservation of ecosystem services is increasing in relative value. This evidence lays the foundations and economic rationale for increased investment in conservation which is central to realizing the targets and issues coming out of the recent meeting of the parties to the Convention on Biological Diversity held in Nagoya.

UNDP hopes that the evidence from the region combined with the economic valuation approach developed in this report will provide a platform for country-level economic analysis of ecosystem services which in turn will feed into national policy dialogue and action. Thus UNDP looks forward to continuing its engagement with regional institutions, government and civil society leaders, experts and other key stakeholders in Latin America and the Caribbean to strengthen, discuss and promote the key ideas and conclusions of the Report. The next steps to build on this report will be capacity building on the economic valuation approach for sectoral analysis at the country level within the region. The approach and results of this Report also have global lessons and implications for countries to value their ecosystem services and integrate them into sectoral development.



Veerle Vandeweerd
Director, Environment and Energy Group
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GLOSSARY

Business as Usual (BAU) and Sustainable Ecosystem Management (SEM): generic concepts used as the basis for assessing the economic values of ecosystem services (ES). This Report focuses on these two contrasting, archetypical categories or scenarios, into which virtually all the practices can be fit. This focus on BAU and SEM also acknowledges that a wide range of natural resource management practices exist.

The more conventional set of management practices optimizes short-run gain without consideration of ecosystems or to externalized costs; this set is termed Business As Usual (BAU). The other scenario focuses on long-term output, inclusive of all impacts and costs; this contrasting set is dubbed Sustainable Ecosystem Management (SEM). BAU refers not to all current activities but those activities that damage or deplete ES. BAU is characterized by a focus on short-term gains (e.g., < 10 years), externalization of impacts and their costs, and little or no recognition of the economic value of ES. Under a SEM scenario, the focus is on long-term gains (10-20 years), while the costs of impacts are internalized. Degradation of ES is avoided, thereby generating potential for a long-term flow of ecosystem goods and services. SEM practices tend to support ecosystem sustainability, not for ideological reasons, but, rather, as a practical, cost-effective way to realize long-run profits.

Within sectors, there is consensus in each sector on steps that move in the direction of BAU or SEM. For example, though the concept of SEM may not prescribe exact levels of pesticide application, reducing pesticide overuse is a clear step toward SEM and away from BAU. Similarly, improved soil conservation in agriculture, reduced by-catch in fisheries, low-impact logging in forestry, and reduced water use in tourist hotels are all examples of marginal changes away from BAU and toward SEM.

Community Co-management: control of the means of production by local resource users in partnership with local authorities and other stakeholders, such as technical experts, NGOs, private enterprise, and other parties. Often associated with organization and monitoring of local territorial use rights in fishing (TURF) systems, community co-management is variously known also as community-based co-management, or participatory, stakeholder, or cooperative management.

Ecosystem: a natural unit consisting of all plants, animals, and micro-organisms (biotic factors) in an area functioning together with all of the non-living physical (abiotic) factors of the environment; an ecosystem is a completely independent unit of interdependent organisms that share the same habitat. Ecosystems provide fundamental life-support services upon which human civilization depends (N. Mandela, Durban, 2007).

Ecosystem Resilience: the capacity of an ecosystem to return to its original state following a perturbation. From the perspective of human use, ecosystem resilience is the capacity of a system to sustain a shock and still retain its basic capacity to provide the ES fundamental to human well-being (Holling 1973; Walker and Salt 2006)

Ecosystem Services (ES): inputs to economic processes provided by natural assets. ES are tangible contributions of ecosystems and biodiversity to production and value creation. The provision of ES is assumed to include the relevant value of ecosystems and biodiversity, therefore, ES is the term used as shorthand for these nature-based services in the Report.

ES are viewed as one of several inputs required for production, along with labor, technology, and capital. They both affect and are affected by production practices. The relative value of ES will vary, depending on ES abundance, the costs and impacts of other inputs, and the policy framework. The term ES is used as a proxy for the way biodiversity interfaces with or

GLOSSARY (continued)

feeds into economic processes. Under BAU schemes, ES are generally treated as free inputs and are subject to degradation or depletion. Under SEM schemes, the value of ES is taken into account and maintained.

The Millennium Ecosystem Assessment (MA 2005) presents a framework to assist in identification of ES. The list includes provisioning services such as food chains, water, timber, and non-forest timber products (NTFPs); regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling. ES are derived from both native and managed biodiversity. To be considered a service, a flow of resources must result directly or indirectly in greater human welfare. Conceptually, healthy and biodiverse ecosystems generate greater amounts, higher quality, and more stable flows of ES over time.

Environmental Fiscal Reform (EFR): a range of taxation or pricing instruments to raise revenue while furthering environmental goals, by providing economic incentives to correct market failures in the management of natural resources and pollution. Broadly speaking, EFR can (1) mobilize revenue for governments, (2) improve environmental management practices and conserve resources, and (3) reduce poverty. By encouraging more sustainable use of natural resources and reducing pollution, EFR addresses environmental problems that threaten the livelihoods and health of the poor. Revenues raised can also be used to finance poverty reduction measures (World Bank 2005).

Exclusive Economic Zone (EEZ): a form of TURF at the international level that provides countries with special rights over the marine resources within 200 nautical miles of their shores.

Externalities are benefits or costs generated as unintended by-products of an economic activity that do not accrue to the parties involved in the activity and where no compensation takes place. Environmental externalities are benefits or costs that manifest themselves through changes in the physical-biological environment. Pollution emitted by road vehicles and by fossil fuel-fired power plants is known to result in harm to both people and the environment. In addition, upstream and downstream externalities, associated with securing fuel and waste disposal, respectively, are generally not included in power or fuel costs. To the extent that the ultimate consumer of these products does not pay these environmental costs, nor compensates other people for harm done to them, these actors do not face the full cost of the services they purchase (i.e., implicitly, their energy use is being subsidized; thus, energy resources will not be used and allocated efficiently (Owen 2004).

G8/G20 Summit: Joint Statement on Biodiversity. The leaders of the world's most industrialized countries gather annually at G-8 summits to discuss a broad range of issues, such as fiscal and monetary policy coordination, and international development. Industrialized countries and leading emerging countries also meet regularly at G-20 meetings, which have become an important international forum to advance economic cooperation. In 2010, the following Joint Statement was adopted:

“At the UN International Year of Biodiversity, we regret that the international community is not on track to meeting its 2010 target to significantly reduce the rate of loss of biodiversity globally. We recognize that the current rate of loss is a serious threat, since biologically diverse and resilient ecosystems are critical to human well being, sustainable development and poverty eradication. We underline our support for Japan as it prepares to host the tenth meeting of the Conference of the Parties to the Convention on Biological Diversity this October and in particular we underline the importance of adopting an ambitious and achievable post-2010 framework. We recognize the need to strengthen the science-policy interface in this area, and in this regard we welcome the agreement to establish an Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).”

GLOSSARY (continued)

Harvest Control Rules (fisheries): conventions by which catch limits are set. Common examples are

Constant catch – fisheries management decision rule to maintain constant catches regardless of changes in stock sizes. This decision rule does not include a feedback mechanism and is usually outperformed by constant escapement or constant fishing mortality.

Constant escapement – fisheries management decision rule to ensure that, as far as possible, a constant stock size is left unharvested after fishing. This rule, generally, leads to higher overall catches but greater variability in landings than the constant fishing mortality decision rule.

Constant fishing mortality – fisheries management decision rule to maintain constant fishing mortality. Like constant escapement, this decision rule includes a feedback mechanism: the total allowable catch (TAC) will decrease if stocks decline.

Hydrologic Function: a series of cascading relationships—from the headwaters to the sea—in which ecosystems in conditions that vary from pristine to heavily modified interact with built infrastructure to supply water for human needs across the landscape.

Indemnity: a sum paid by A to B by to compensate for a particular loss suffered by B. The indemnitor (A), the fund, may not be responsible for the loss suffered by the indemnitee (B). Forms of indemnity include cash payments, repairs, and replacement. The indemnity fund (IF) can serve as a transfer mechanism to replace reductions in natural capital (in this case, timber and intact forest ecosystems) with additions to financial capital. Provided the financial assets prove adequate substitutes for the forgone physical assets, this procedure assures sustainability of overall value (Katzman and Cale 1990). Establishment of the IF requires strong partnership between concessionaries, local governments, and protected area authorities, and a high degree of institutional transparency and accountability. In the context of forest concessions, the proceeds of the concession would be deposited into the IF and by the end of the harvest period could be quite large (in a Brazilian example, between US\$ 140 M and US\$ 1.3 B). The low-impact controlled logging SEM model, combined with a tax scheme and an IF, provides the capability of generating an optimal, long-term pattern of increased tax revenue to national and local agencies, with sustainable asset stocks and consumption paths. For example, the fund's resources can be used to finance forest projects in protected areas and buffer zones such as plantation forestry or conservation easements, long after the exploitation cycle has finished.

Individual Transferrable Quotas: a type of catch share, part of a TAC limit on a fishery, which can be traded among fishers. Often initially sold at auction by the entity governing the fishery, a TAC is generally valid for a particular time span (season, year, multi-year).

Payment for Environmental/ Ecosystem Services (PES): a means of influencing landowners or other resource tenants to manage their holdings in specific, environmentally-friendly ways, often by maintaining or improving forest cover, conserving soil and water, reducing greenhouse gas emissions, improving waste disposal, or employing similar practices. Classically, payment schemes are used to compensate upstream managers for taking into account the needs of downstream resource users. Programs may be organized by governments, civil society, or other entities; payments may come from public funds, affected entities, or international programs, among other sources.

Payment for Watershed Services (PWS): a type of payment for environmental services involving watershed level and water-related services.

GLOSSARY (continued)

Perverse Subsidies: subsidies made for economic reasons that have side effects that hurt the environment; in this case, those subsidies that make continuation of BAU practices relatively cheaper and/or the transition to SEM more costly. Examples include subsidized machinery (e.g., logging equipment, harvesters, fishing vessels, and tourist vans) or fuel, pesticides, and other items that lower the cost of BAU operations, leading to over-capacity and/or overharvesting with respect to what the market would bear without the subsidies.

Portfolio Effect: the idea that higher biodiversity leads to stability because it provides more species that could “take over” ecosystem functions of depleted or missing species, like a diversified financial portfolio with a variety of stock and bonds that will be affected differently by contingencies, thereby smoothing out results.

Reducing Emissions from Deforestation and Degradation (REDD, REDD+): United Nations Collaborative Program on Reducing Emissions from Deforestation and Forest Degradation (REDD). REDD promotes and governs the current set of pilot forest carbon initiatives; Redd-plus (REDD+) is the new version proposed for adoption in the post-Kyoto climate change framework.

Representativity: The degree to which a protected areas system provides coverage of ecosystems representing the natural variety of such systems in a country or a region.

Sustainable Ecosystem Management (SEM): see definition under Business as Usual (BAU).

Territorial Use Rights In Fisheries (TURF): Rights awarded to fishers (individuals or entities), where conditions allow definition of and protection of rights to geographically-tied resources such as shellfish beds, reef fishing, crab trapping grounds, lagoons, or other resources. TURF schemes provide “sea tenure” that permits fishers to invest in maintaining or improving the resource (since other actors will not be allowed to harvest there); In the case of TURF and where catch limits also apply, these fishers are able to fish without haste, doing a better, more cost-efficient job of harvesting (thereby avoiding the “race to fish”). TURF systems have been used to increase the welfare of small-scale fishing communities that, otherwise, would remain exposed to open competition for common property resources. TURF schemes have also been applied in forestry to regulate exploitation of NTFPs.

Total Authorized Catch (TAC): the number or tonnage of fish allowed to be landed in a given period from a particular fishery, combining the catches of all fishers.

ACRONYMS AND ABBREVIATIONS

ABC	Activity-Based Cost
ACTO	Amazon Cooperation Treaty Organization
AJER	Alto Juruá Extractive Reserve (Brazil)
AMBAS	Women's Community Development Association of Barra de Santiago (El Salvador)
AMERBs	Areas for the Management and Exploitation of Benthic Resources
ANAI	Nonprofit organization in Costa Rica
ANMI	Natural Area of Integrated Management
AOW	All Over the Watershed
ARPA	Amazon Region Protected Areas
ASTOP	Association to Save the Turtles of Parismina (Costa Rica)
ATDI	Adventure Travel Development Index
AUSAR	Areas Under Special Administration Regime
BAU	Business As Usual
BD	Biodiversity
BINGOS	Big International Nongovernmental Organizations
BIOAMAZONIA	Brazilian Association for the Sustainable Use of the Biodiversity of Amazonia
BNDES	Brazil's Ministry of Tourism and Development Bank
BRMEA	Benthonic Resources Management and Exploitation Areas
BT Fund	BioTrade Fund
C	Carbon
C.A.F.E.	Coffee and Farmer Equity
CABEL	Central American Bank for Economic Integration
CARE	US-based international humanitarian organization
CAREC	Caribbean Epidemiology Center
CAST	Caribbean Alliance for Sustainable Tourism
CATIE	Tropical Agricultural Research and Higher Education Center
CBA	Cost-Benefit Analysis
CBD	Convention on Biological Diversity
CC	Climate change
CCAS	Climate Community Alliance Standards
CCT	Tropical Science Center (Costa Rica)
CEDERENA	Corporation for the Development of Natural Resources (Ecuador)
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CEIA	Environmental Education and Interpretation Center
CER	Certified Emission Reduction
CESD	Center on Ecotourism and Sustainable Development
CFE	Federal Commission of Electricity
CI	Conservation International
CIAT	International Center for Tropical Agriculture

ACRONYMS AND ABBREVIATIONS (continued)

CIDAC	Center of Research for Development
CINPE	International Center of Economic Policy for Sustainable Development (Costa Rica)
CIPTA	Indigenous Council of the Tacana People (Bolivia)
CL	Conventional Logging
CLAS	Carnegie Landsat Analysis System
CNFL	National Power Company and Light (Costa Rica)
CNNP	Chingaza National Natural Park (Colombia)
CNP	Coiba National Park (Panama)
COC	Chain of Custody
Coelba	Electric Company of Bahia (Brazil)
CONAGUA	National Commission for Water (Mexico)
CONANP	National Commission of Natural Protected Areas (Mexico)
CONAP	National Council on Protected Areas (Guatemala)
COP	Convention of Parties
CPF	Collaborative Partnership on Forests
CPM	Center for Park Management
CRA	Coral Reef Alliance
CRMP	Coastal Resources Management Project
CSF	Conservation Strategy Fund
CV	Contingent Valuation
CW	Controlled Wood
CWR	Crop Wild Relatives
DE	Daily Expenditure
DECR	Department for the Environment and Coastal Resources
DIFD	Department for International Development
DMP	Disaster Management and Prevention
DWCF	Disney Wildlife Conservation Fund
EAAB	Water and Aqueduct Company of Bogota (Colombia)
EAF	Ecosystem Approach to Fisheries
EAR	Eduardo Avaroa Reserve (Bolivia)
ECLAC	United Nations Economic Commission for Latin America and the Caribbean
EDELCA	Caroni Electrification Company (Venezuela)
EEZ	Exclusive Economic Zone
EFR	Environmental Fiscal Reform
EGEHID	Enterprise for Hydropower Generation (Dominican Republic)
EIA	Environmental Impact Assessment
EM	Effective Microorganism
Embasa	Empresa de Agua e Saneamento da Bahia/ Company for Water and Sanitation of Bahia (Brazil)
ES	Ecosystem Services

ACRONYMS AND ABBREVIATIONS (continued)

ESPP	Environmental Service Payments Program
EU	European Union
EVW	Economic Value to the World
FAO	Food and Agriculture Organization
FCCC	United Nations Framework Convention on Climate Change
FERN	NGO that monitors forest use (European Union)
FI	Financial Intermediary
FLONAS	Florestas Nacionais, National Forests (Brazil)
FM	Forest Management
FONAFIFO	National Forestry Financing Fund (Costa Rica)
FONAG	Water Conservation Fund (Quito, Ecuador)
FRA	Forest Resources Association Inc.
FSC	Forest Stewardship Council
FUDENA	Nature Defense Foundation (Venezuela)
FUNDAMBIENTE	Environmental Foundation (Venezuela)
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Geographic Information System
GMO	Genetically-Modified Organism
GNP	Galapagos National Park (Ecuador)
GSSCMR	Gladden Spit and Silk Cays Marine Reserve (Belize)
GtC	GigaTons of Carbon
GTZ	German Agency for Technical Cooperation
GW	Ground Water
HRA	High Risk Areas
IADB	Inter-American Development Bank
IBAMA	Brazilian Institute of Environment and Renewable Natural Resources
ICCL	International Council of Cruise Lines
ICE	Costa Rican Institute of Electricity
ICMS	Tax on the Circulation of Goods and Services (Brazil)
ICRAN	International Coral Reef Action Network
IDB	Inter-American Development Bank
IF	Indemnity Fund
IFC	International Finance Corporation
IHEI	International Hotels Environment Initiative (now the International Tourism Partnership)
IIED	International Institute for Environment and Development
ILMB	Integrated Land Management Bureau
ILO	International Labour Organization

ACRONYMS AND ABBREVIATIONS (continued)

IMA	Inter-institutional Management Authority
IMF	International Monetary Fund
INAT	National Institute for Land Adequacy (Colombia)
INBio	Biodiversity Institute
INCAE	Central American Institute of Business Administration
INE	National Institute of Ecology
INPA	Instituto Nacional de Pesquisas da Amazônia (Brazil)
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated Pest Management
IRR	Internal Rate of Return
ISA	Instituto Socio-ambiental de Bolivia
ISOCARP	International Society of City and Regional Planning
ITQ	Individual Transferable Quota
ITTO	International Tropical Timber Organization
IUCN	International Union for Conservation of Nature
IUU	Illegal, Unregulated, and Unreported (Fishing)
JASEC	Administrative Board of Electric Service of Cartago (Costa Rica)
JNF	Jamari National Forest
LAC	Latin America and the Caribbean
LUCC	Land-Use and Land-Cover Change
LUCF	Land-Use Change and Forestry
M&I	Municipal and Industrial
MA	Millennium Ecosystem Assessment
MBR	Maya Biosphere Reserve
MEY	Maximum Economic Yield
MINAE	Ministry of Environment and Energy
MINAM	Ministry of the Environment (Peru)
MINAMB	Ministry of People's Power for the Environment (Venezuela)
MOPAWI	Non-Governmental Development Agency of the Mosquitia Region (Honduras)
MPA	Marine Protected Area
MPD	Managed Pressure Drilling
MRAG	Marine Resources and Fisheries Consultants
MSC	Marine Stewardship Council
MSY	Maximum Sustainable Yields
NA	Not Applicable
NAAAAL	Nueva America Autonomous Association for Agriculture and Livestock
NATURA	Nature Foundation (Bolivia)
NBT	Nature-Based Tourism (Eco-Tourism)

ACRONYMS AND ABBREVIATIONS (continued)

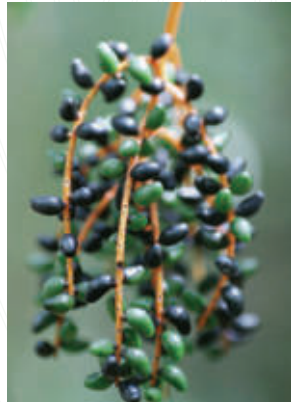
ND	Number of Days of Stay
NGO	Non Governmental Organization
NPM	Madidi National Park (Bolivia)
NPV	Net Present Value
NSPA	National System of Protected Areas (Bolivia)
NTFP	Non-Timber Forest Products
NTFR	Non-Timber Forest Resources
NV	Number of Visits
OAS	Organization of American States
OECD	Organization for Economic Co-operation and Development
OMT	World Tourism Organization (UNWTO)
OTC	Over The Counter
PA	Protected Area
PACT	Protected Areas Conservation Trust (Belize)
PAME	Protected Area Management Effectiveness
PANE	Heritage of National Natural Areas of the State (Ecuador)
PAS	Protected Area System
PE	Planting Empowerment
PEFC	Programme for the Endorsement of Forest Certification
PES	Payment for Environmental/Ecosystem Services
PINFOR	Forest Incentive Program
PMB	Participatory Management Board
PNAS	Proceedings of the National Academy of Sciences
PPD	Small Grants Program (Costa Rica)
PROFONANPE	National Fund for Natural Protected Areas (Peru)
PROFOR	Program on Forests
Projeto TAMAR	Marine Turtle Conservation Program (Brazil)
PROLOCAL	Poverty Reduction and Local Rural Development Program
PROMETA	Foundation for Protection of the Environment of Tarija (Bolivia)
PSAH	Program of Hydrological Environmental Services
PSU	Practical Salinity Unit
PVB	Present Value of Benefits
PVC	Present Value of Costs
PWS	Payment for Watershed Services
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	New version of REDD (post-Kyoto regime)
RIL	Reduced Impact Logging
ROI	Returns on Investment
SAN	Sustainable Agriculture Network

ACRONYMS AND ABBREVIATIONS (continued)

SAUP	Sea Around Us Project
SCBD	Secretariat of the Convention on Biological Diversity
SCP	Soil Conservation Practice
SEAFDEC	Southeast Asian Fisheries Development Center
SEM	Sustainable Ecosystem Management
SEMARNAP	Secretary of Environment, Natural Resources and Fishing (Mexico)
SEMARNAT	Environment and Natural Resources Secretary (Mexico)
SFB	Serviço Forestal Brasileiro (Brazilian Forest Service)
SGAs	Sub-Global Levels
SHCP	Secretariat of Finance and Public Credit (Mexico)
SICAP	Central American System of Protected Areas
SINAC	National System of Conservation Areas (Costa Rica)
SINANPE	National System of Protected Natural Areas (Peru)
SMEs	Small and Medium Enterprises
SMMEs	Small, Micro, and Medium Enterprises
SMPZ	Special Marine Protection Zone
SNAP	National System of Protected Areas (Ecuador)
SNUC	National System of Conservation Units (Brazil)
SNV	Netherlands Development Organization
SPAG	Spawning Aggregations
SPC	Soil Conservation Practices
SPNN	National System of Natural Parks (Colombia)
STINAPA	National Parks Foundation (Netherlands Antilles)
SW	Surface Water
TAC	Total Authorized/Allowable Catch
TCI	Turks and Caicos Islands
TE	Total Expenditure
TEEB	The Economics of Ecosystems and Biodiversity
TEV	Total Economic Value
TIM	Tourism Income Multipliers
TIPNIS	Isiboro Sécore National Park and Indigenous Territory (Bolivia)
TNC	The Nature Conservancy
TOI	Tour Operator Initiative
TPSP	Três Picos State Park (Brazil)
TURF	Territorial Use Rights in Fisheries
UMSA	Universidad Mayor de San Andrés (Bolivia)
UN IPCC	United Nations Intergovernmental Panel on Climate Change
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe

ACRONYMS AND ABBREVIATIONS (continued)

UNEP	United Nations Environment Programme
UNEP-CEP	United Nations Environment Programme-Caribbean Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNWTO	United Nations World Tourism Organization
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
UZACHI	Union of Zapotec and Chinantec Indigenous Communities
VAT	Value Added Tax
VMS	Vessel Monitoring System
WCMC	World Conservation Monitoring Centre
WCS	Wildlife Conservation Society
WDPA	World Database on Protected Areas
WGI	Worldwide Governance Indicators
WHO	World Health Organization
WTO	World Trade Organization
WTP	Willingness to Pay
WTTC	World Travel and Tourism Council
WWF	World Wildlife Fund



PART I

INTRODUCTION

CHAPTER 1.

INTRODUCTION

Andrew Bovarnick¹ and Francisco Alpizar²

“A nation’s prosperity depends on its competitiveness, which is based on the productivity with which it produces goods and services. Sound macroeconomic policies and stable political and legal institutions are necessary but not sufficient conditions to ensure a prosperous economy. Competitiveness is rooted in a nation’s microeconomic fundamentals — the sophistication of company operations and strategies and the quality of the microeconomic business environment in which companies compete. An understanding of the microeconomic foundations of competitiveness is fundamental to national economic policy.”

The Harvard Institute for Strategy and Competitiveness



1.1 BACKGROUND

The Latin American and Caribbean region (LAC) grew its GDP continuously from 2002 to 2008; yet 25% of its population still lives on less than \$2 a day.³ For LAC to prolong its economic growth and persist in its poverty reduction efforts, the region needs to remain competitive and take advantage of its assets. One major asset for the region is its variety of ecosystems, well endowed with high levels of biodiversity.

LAC countries are among the world’s most well endowed in natural capital: biodiversity and ecosystems. South America has more than 40% of the Earth’s biodiversity, more than one-quarter of its forests and is the single most biologically diverse area in the world. This biodiversity and these ecosystems provide ecosystem services (ES), which directly provide inputs into the production of key sectors in LAC economies — particularly water, soil fertility, pollination, pest control, and growth and reproduction of food species, as well as storm mitigation, climate regulation, waste assimilation, and many other functions.

Steady economic progress by conventional means has accumulated benefits for societies in LAC and beyond, but has also led to considerable depletion of the region’s natural asset base and the associated ES. These trends raise a question for policy makers, business and civil society leaders, and local governments:

Is the competitiveness of countries in Latin America and the Caribbean at risk from increasingly high hidden costs and missed market opportunities because of current approaches to economic growth that ignore ecosystem services? Can maintenance and capture of the economic value of ecosystem services strengthen LAC competitiveness and sustain growth?

¹ Lead Natural Resource Economist, UNDP.

² Coordinator and a Senior Research Fellow, Environment for Development Center, CATIE.

³ Unless noted, the amounts in this document are presented in US currency of dollars and cents. “Billion” means a thousand million; “trillion” means a thousand billion.

Data from some economic sectors show that current practices make the most sense from an economic or business perspective. However, growing evidence suggests that in certain sectors and countries, environmental damage and opportunity loss, increasingly, will hamper economic growth.

In order to answer these questions it is time to clarify the relation between the provision of ES and economic growth and equity in LAC, moving the issue of ES into the arena of economic policy and enhancement of competitiveness. In response to this need UNDP's Regional Bureau for Latin America and the Caribbean has developed an initiative: "Latin America and the Caribbean: A Biodiversity Superpower" and has prepared this Report for the UN Year of Biodiversity. UNDP has partnered in this initiative with institutions including CBD, UNEP/TEEB, ECLAC, IUCN, WWF, CI, TNC, and CATIE, and has also received generous support from the government of Spain. Report preparation has engaged key political and economic leaders of the region through a UNDP-led Commission on Biodiversity, Ecosystems, Finance and Development, as well as by a series of consultations with national stakeholders, research institutions, and NGOs across the region.

It is not intended that the main Report be read straight through; most readers will have specific interest in one or a few sectors. Chapters have been made free-standing, not dependent on reading in sequence. But it is advised to read the introduction and methodology prior to reading a sector chapter as the key concepts are described there.

1.2 OBJECTIVE OF REPORT

This Report aims to inform policy makers and businesses in LAC about the economic risks and opportunities of undertaking productive activities that impact on and are influenced by biodiversity and ES.⁴ The Report is a tool to assist governments and stakeholders to analyze the role of ES in order to incorporate them into economic planning, policy and investment at the sectoral level. To achieve this objective, the Report specifically:

- 1) Highlights the economic costs and benefits associated with contrasting management approaches to producing sectoral outputs: those approaches that disregard the underlying ecosystems and those that incorporate and sustain them.
- 2) Assesses the economic contribution of biodiversity conservation and economic services to economic growth and equity in natural resource sectors in LAC and how these economic contributions change as ecosystems are impacted.

3) Showcases innovative and successful resource management models undertaken by private firms, governments, research institutes, and NGOs in the region and throughout the world, emphasizing the need to innovate and the role of creative thinking in finding new ways to increase economic outputs while preserving the natural resource base.

4) Provides examples of new opportunities for growth emerging from global "green" markets to show how sustainable ecosystem management can unveil future economic growth strategies for LAC, and to highlight the increasing demand for socially and environmentally responsible investments worldwide.

5) Proposes regionally-tailored policy solutions to generate economic growth through conservation and investment in biodiversity assets and ES.

6) Establishes a new methodological approach on valuation, which can be applied within sectors and countries, and identifies further research needed in LAC to analyze the economic value of ecosystems.

These analyses and assessments present economic data on biodiversity and ecosystems in a manner that is relevant to policy makers and business in LAC. The Report focuses on revealing the economic value of ES to fill an important gap in current knowledge on this subject, neither judging nor promoting the commodification of the natural environment. Fully recognizing non-economic values – ethical, spiritual, social, and cultural – the Report focuses on the economic aspects of ES values.

This Report is a first step in a long-term effort to build country capacity and support sectoral policy reform. The Report provides a methodological platform for follow-up national level studies to highlight the economic importance of biodiversity and ES. UNDP looks forward to continuing its engagement with regional institutions, government and civil society leaders, experts, and other key stakeholders in LAC to strengthen, discuss, and promote the key ideas and conclusions of the Report.

1.3 THE ECONOMIC AND ECOSYSTEM DISCONNECT

Latin America and Caribbean countries have a history of economic growth based on natural resources, namely commodity production and export, and more recently tourism. National governments have

⁴ The provision of ES includes the relevant value of ecosystems and biodiversity, so that the term ES will be used as shorthand for the value of ecosystems and biodiversity throughout the Report.

supported sectoral growth to drive national economic development. Production plans and practices have optimized yield and earnings, seldom considering the relationships between those outputs and the inputs derived from the natural resource base. Consequently, LAC has experienced economic growth but also depletion of its natural resources, biodiversity, and ES — that is, some of the very same inputs that have fueled sectoral growth. Now, poor ecosystem management is leading to a relative scarcity of vital ES (e.g., water supply, provisioning services of soil, waste-absorbing capacity, etc.).

The economic benefits of sectoral output and growth are well documented and known, while the economic costs from the externalities are not. Hence, they go unseen, not considered in policy making and investment decisions. Indeed, the costs of ES degradation are difficult to measure in economic terms. Yet, increased scarcity of ES puts at risk the production of natural resource-based goods and services and limits capacity to generate human wellbeing and reduce poverty.

Emerging patterns in the global marketplace increase the benefits to sectoral actors that manage ecosystems sustainably. Consumers in major global markets — US, Europe, and Japan — are selecting products which are sustainable and produced without externalities and associated costs to society. This demand side pull towards good environmental performance is leading to changes in production practices used to generate sectoral outputs in LAC and globally. A growing number of management practices take into account externalities, reduce them, and produce products while sustaining the ES that support their production. These management practices have growing economic benefits and can be compared to conventional practices to determine the true economic benefits and costs of managing ecosystems well or poorly.

Economic practices are shaped by these costs and benefits. Production costs are influenced by the costs of inputs, which, in turn, are affected by policies like energy and water subsidies, pollution standards, and control of illegal logging or fishing. Policy initiatives change the cost-benefit ratios of specific economic activities. Hence, it is important for policy makers to understand under what circumstances maintaining ecosystems and their services may generate greater economic benefit than does permitting economic processes that degrade and deplete ecosystems.

While some studies have estimated these benefit values associated with ecosystems, there has not been sufficient information, presented in a manner relevant to policy makers, that shows the contribution by ES to sectoral outputs, in relation to the costs and benefits associated with different management approaches. This lack of information has contributed to the dominant view that the economic benefits of conventional practices outweigh the costs and that investing in biodiversity and ecosystem conservation does not present positive returns to the economy.

Hence, the need to present policy makers economic data on ES, their relation to sectoral productivity, and the existence of practical,

sustainable, and potentially more profitable alternative management practices.

1.4 APPROACH OF REPORT

Sectoral Approach

The Report, in order to be relevant to policy makers, takes a sectoral approach to align with the organization of Ministries, instead of an ecosystem-centric approach that cuts across sectors and ministerial mandates. The approach considers biodiversity assets and ES as inputs into a country's economic sectors and presents data on the economic value of ES to each sector. A range of sectors closely tied to renewable natural resources has been selected to analyze to what degree they depend economically on natural inputs in LAC and what opportunities these sectors have to benefit from maintaining ES. The sectors analyzed are:

- | | |
|-----------------------|--|
| 1) Agriculture | Two more are presented as cross-cutting areas: |
| 2) Fisheries | |
| 3) Forestry | 5) Protected areas |
| 4) Tourism | 6) Hydrological services |

Other sectors that have a large impact on ecosystems, such as mining and infrastructure, are not included since they are not as dependent on ecosystem functioning. Mines require mineral resources but not the ecosystems in which they are located. Roads can be vulnerable to flooding or landslides, but the main relationship is their impact on ecosystems, not the other way around. There are yet other areas within national economies where biodiversity and ES do play a role and are linked by clear economic benefits and costs to sustainable ecosystem management. These pertain to areas of energy production (e.g., hydropower and biomass), human settlements, natural disaster vulnerability reduction (e.g., the role of mangroves in mitigating storm damage) and health (e.g., vector control). These areas are important and should be the focus of future work supplementary to this Report. The sectors highlighted here are those that are most clearly influenced by ecosystem inputs into their productivity and economic output.

Each of the sectoral analyses focuses on selected sub-sectors. For example, the agricultural analysis concentrates on crop production and agroforestry. Fisheries focus on marine capture and not on aquaculture or freshwater capture. Forestry includes logging from secondary forests as well as plantation forestry. Tourism focuses on mainstream nature-based tourism and ecotourism. The protected areas chapter is crosscutting and focuses on contributions of protected areas (PAs) to agriculture, fisheries, forestry, and tourism. Hydrological services is also crosscutting and focuses on the interactions between upstream and downstream water, and land-use practices and externalities.

Each sector analysis presents the relationships between outputs, ES, and other inputs, as well as showing feedback loops (e.g., pesticides on crops damage pollinator populations, lowering pollination rates and agricultural output). Examples are given of ecosystem degradation that lowers outputs and the costs associated. Then, management practices that avoid damaging ecosystems are identified and the economic benefits to the sector from sustained ecosystems are illustrated. This organization and presentation of data shows the economic relations between ES, contrasting management practices, and specific outputs.



The economic and ecological analysis within the sectors is not divorced from institutional and policy frameworks; relevant needs and the data are discussed in the context of governance and policy. The sectoral analysis undertaken is then used to propose tools and formulate practical recommendations that can be applied by decision makers to capture and build upon the economic relationships of sectors with ES.

This sectoral approach was chosen for its advantage in relating to the work of ministries and public agencies, each with its particular focus. This approach has some constraints: it disaggregates the total economic value of each type of ES and fragments system-wide values to show specific sectoral inputs. The integration of overall effects of ecosystems and their services on the economy as a whole is left to the conclusions.

1.5 REPORT STRUCTURE

Part I frames the links between biodiversity and ES to sectoral outputs, national economic growth, and equity. This part explains current regional trends and reasons for business as usual.

Part II makes conclusions and policy recommendations based on the analytical framework laid out in Part I and the findings from Part III.

Part III presents the sectoral analysis and findings in agriculture, forestry, health, fisheries, and tourism. There are also two cross cutting chapters: protected areas and hydrological services.

Each sectoral chapter is structured roughly as follows. In some cases, topics are combined:

- **Role of sector in national economies**
- **Role of ES in sector**
- **Costs of BAU (business as usual)**
- **Case studies**
- **Benefits of SEM
(sustainable ecosystem management)**
- **Conclusions**
- **Policy recommendations**

Note to readers: It is not intended that this Report be read straight through cover to cover. The Report covers several sectors; most readers will have specific interest in one or a few sectors. Thus, chapters have been made free-standing, not dependent on reading in sequence. It is recommended that readers consider reading the introductory chapters 1-3, those on particular sectors of interest, and in the conclusions and recommendations chapters.

CHAPTER 2.

METHODOLOGY OF ECONOMIC ANALYSIS

Andrew Bovarnick⁵ and Francisco Alpizar⁶

The Report's methodology is to analyze sectoral outputs at a micro-economic level, comparing costs and benefits between different types of natural resource management practices. While acknowledging that there exist a wide range of such practices, to simplify the analysis the Report focuses on two contrasting, archetypical categories, or scenarios, into which virtually all the practices can be fit. Since natural resource management practices are often influenced by overarching institutional and policy frameworks, these scenarios include those frameworks that affect these practices. The more conventional set of management practices optimizes short-run gain without consideration to ecosystems or to externalized costs; this set of management practices is termed Business As Usual (BAU). The other scenario focuses on long-term output, inclusive of all impacts and costs; this set of practices is dubbed Sustainable Ecosystem Management (SEM).

BAU and SEM are taken to be different ends of a spectrum of production options with regard to their consideration of ES as a production input. Movement toward SEM can be made by BAU operations, without necessarily reaching a full SEM model of production. The aim is to compare qualitative differences since production practices vary along the range of options between BAU and SEM.

Ecosystem services are used as proxies for biodiversity that feed into economic processes, since they are easier to connect with sectoral outputs. Under BAU, ecosystem services are generally treated as free

inputs and are subject to degradation or depletion. Under SEM, ES are taken into account and maintained.

The Report focuses on practical management and policy issues that can be adopted and promoted by line Ministries, businesses, and other stakeholders, which could impact production and/or employment at the firm or industry level. As such, a general equilibrium model has not been developed and only limited attention is provided to macro-economic indicators like GDP or national employment.

The Report focuses on practical management and policy issues that can be adopted and promoted by line Ministries, businesses, and other stakeholders, which could impact production and/or employment at the firm or industry level.

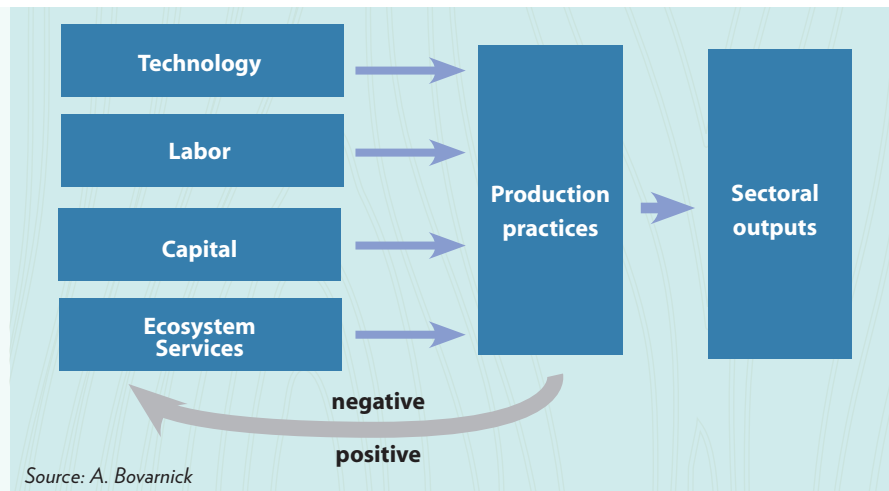
The Report reviewed the literature on economic values of natural resources and attempted to present these values in the context of indicators of wellbeing (like growth and employment) at the sectoral level. Whenever possible, the equity perspective behind alternative ecosystem management strategies is also highlighted — an important facet that is frequently overlooked in valuation exercises. Where traditional valuation studies concentrate on ecosystems, this Report focuses on sectoral impacts that transect the cross-cutting features of ecosystems.

Comparative analysis between BAU and SEM is prepared for each sector investigated to increase relevance of the findings to sectoral policy makers. Comparisons are not comprehensive due to the paucity of economic data about ecosystems and sectoral outputs. The Report highlights certain costs and benefits to illustrate issues that need to be considered in planning and policy formulation.

⁵ Lead Natural Resource Economist, UNDP.

⁶ Coordinator and a Senior Research Fellow, Environment for Development Center, CATIE.

Figure 2.1. Relations among ES and Other Inputs, Production Practices, and Sectoral Outputs



2.1 METHODOLOGY

This section explains the methodology developed to analyze the economic value of biodiversity and ecosystems for LAC and to present this analysis in a manner useful to policy makers.

To simplify, the focus will be on ES that interface with economic processes. The tangible contributions of ecosystems and biodiversity to production and value creation are through these processes. The provision of ES will be assumed to encapsulate and will include the relevant value of ecosystems and biodiversity, so that the term of ES will be used as shorthand for the value of ecosystems and biodiversity throughout the Report.

Ecosystem services are viewed as one of several inputs required for production, along with labor, technology, and capital. These ES both affect and are affected by production practices (Figure 2.1). Their relative value will vary, depending on ES abundance, the costs and impacts of other inputs, and the policy framework. The methodology does not attempt to isolate the input function of each ES and the resulting economic value (as in “1 ha of forest supports X pollinators which increase by Y% the yield of nearby crops, resulting in a gain of \$Z”). In general, such causal relationships prove too complex to tease out and monetize in a comprehensive fashion. For example, a change in levels of tourism arrivals may just as well be due to the quality and price of hotels as to deterioration of natural assets such as beaches or birdlife.

The BAU and SEM approach is a practical way to bridge the disconnect between ES values and planning and policy decision making.

Inference is used to approximate the economic value of ES inputs into production. There are certain production practices which maintain and use ES (grouped under SEM) and there are other practices which degrade ES and rely more heavily on other inputs (categorized as BAU). An example in agriculture might be the difference in farm yields with application of organic compost in a SEM agroforestry context, versus yields using chemical fertilizer in similar situations (e.g., hillside farming) under BAU. On comparing the available evidence from many countries on the costs and benefits of these different production practices, the Report has noted that in those cases in which a full accounting is made, the net benefits are, on average, consistently greater for the SEM practice.

The inference is that this result is due, in substantial part, to the maintenance of ES under SEM (which, in this case, provided fertility without use of chemical fertilizers). The focus is not to verify an exact value for the ES (as noted above, that would be difficult); of greater interest is to see its general direction and magnitude, and how in the service varies with relevant factors.

The BAU and SEM concepts enable the approximate capture of ES value over time — to infer that ES of some sort are operating at a level that permit additional production (over BAU) or lower costs. The BAU and SEM approach is a practical way to bridge the disconnect between ES values and planning and policy decision making. This can be illustrated by the following graphic approach.

Figure 2.2 shows the hypothesis that under BAU, net revenues decline over time, while those of SEM may start lower, but remain constant or rise. This leads to a point at which SEM replaces BAU as

the optimal management approach. The initial advantage of BAU corresponds to its externalization of costs, both current and future; other factors may also come into play, like subsidies. The eventual advantage of SEM is based on the maintenance or improvement of ES under SEM, though other aspects may also influence the situation, like better coordination with stakeholders or subsidies that facilitate transition. Variations on this theme corresponding to the patterns found in the sector analyses are discussed in Section 2.3.

Figure 2.2. Evolution of Net Revenues under BAU and SEM

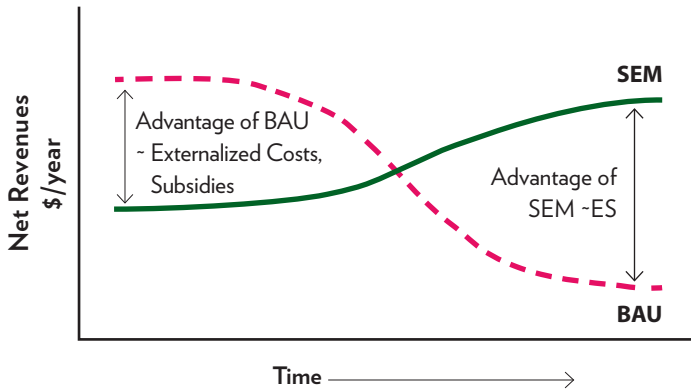
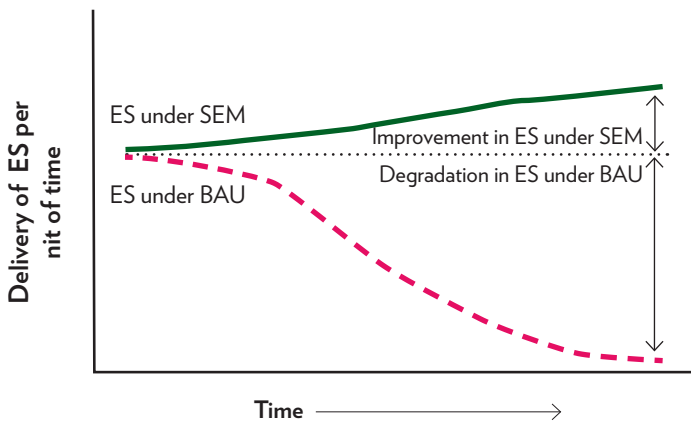


Figure 2.3 indicates what changes are behind the drop in net revenues under BAU. Resource degradation lowers the delivery rate for ES, and is approximated in the distance by which the ES line falls under BAU. For SEM, the ES line maintains its level or rises in response to improvement in the natural resource base under SEM, as shown here. In specific cases, the ES being delivered might be measured in m³/hour of sediment-free water, number/night of turtles available for watching on the beach, or tons/year of fish biomass grown (in the fishery stock itself or in the prey eaten). Depletion of these ES-related resources would lead to lower BAU revenues in the previous graph, Figure 2.2.

Figure 2.3. Changes in Ecosystem Services (ES) under BAU and SEM



This approach enables entrepreneurs and policy makers to perceive overall patterns and to make decisions about specific management practices with a better understanding of overall costs and benefits

related to ES value and maintenance, some of which have previously been hidden as indirect or externalized costs (in the example above, these hard-to-see costs include the soil-depleting effects of BAU management practices, the downstream impacts of fertilizer overuse, the cost of purchasing fuelwood or fruits on non-agroforestry farms, the lack of buffering against market shocks by monocultures, etc.). This method of comparing BAU to SEM provides data beyond a focus on production output — crop yield for agriculture, stock harvest for fisheries and visitor flow for tourism — and allows a fuller trade-off analysis of the hidden (external and future) costs of depleting ES and increasing reliance on purchased inputs. In general, Ministries and enterprises have not had at hand data on ES values within different management practices because much of the current data on ES values are ecosystem focused and not related to management practices. Organizing economic data around BAU (without ES) and SEM (with ES) allows decision makers to compare the costs and benefits of different management practices and focus on the practices that make the most sense.

For example, if analysis shows that coffee farms produce higher yields when situated next to adjacent forests and that these higher yields are, in part, because the forest supports pollinators for the coffee, then the Ministry of Agriculture can weigh the economic benefits to coffee farmers of conserving adjacent forest versus those benefits of converting the forest to new farms. Another example is with pesticide application in agriculture. Ministries can compare farms that undertake BAU practices (i.e., heavy application of pesticide without due treatment with resulting pesticide contamination of adjacent water bodies) that, in turn, affect downstream agricultural production, with farms that undertake SEM practices (reduced pesticide use and cost, with more reliance on integrated pest control and natural predators), as well as reduced water contamination. The downstream costs of water contamination can help policy makers make a more informed decision about the economic value of pesticide application, as well as the flip side — the economic value of maintaining the ES of natural pest control, which can reduce costly reliance on pesticide use (ever higher and more complex as the pests develop resistance).

The methodology recognizes that for policy makers, static (time bound) point data is of limited value. In a situation when choices need to be made between different types of land-use and development practices, data on how much an ecosystem is valued, specifically at in a certain moment under the current management system (such as a coral reef, say) tells the manager nothing about how that value might change. The information that its total annual worth is estimated at \$X million, based on production flows, needs to be supplemented by data on how that value might be lowered if the ecosystem were damaged or how much that value might grow if reduced fishing pressure allowed fish stocks to rebuild.

Point data on ecosystem value does not take into account the status of the resources that contribute to their overall worth. These ecosys-

tems may be healthy or on the verge of crash. Hence, a high value may be due to unsustainable rates of resource depletion, yet be used to convince policy makers unaware of that depletion to maintain current management practices — even though these practices may lead to drastic decline in the ecosystem’s value. (The Fisheries chapter has case studies on Argentine hake and Peruvian anchoveta where precisely that happened: catch levels were maintained because plummeting stock levels were compensated by ever greater investment in fishing fleets — at great eventual cost to both the economic and ecological systems.)

To make well-informed decisions, policy and decision makers need a cost benefit analysis that includes a sensible time dimension to track resource depletion over time. This Report addresses this need as much as data permits by investigating changes in resource management practices over time to show the range of current and future costs / benefits that an economic activity can generate depending on the type of ecosystem management (BAU or SEM as a first approximation). When possible, temporal data sets have been used to show the economic value of ecosystems before and after the introduction of SEM practices.

Across BAU and SEM practices, the Report focuses on economic costs and benefits (direct and indirect) and does not dwell on non-use values. Non-use values are intangible and more difficult for governments to use to compare and select over direct financial gains from degradation of the ecosystem. In practice, these non-use values are dealt with indirectly under SEM through stakeholder consultation and engagement.

Demonstrating causality between ES and economic growth and, particularly, the underlying biodiversity is complex, in part due to variation in the data by sector for each issue, which in turn affects the strength of the conclusions. Where many cases show similar trends in costs or benefits, the conclusions drawn are likely to be more robust and applicable to other cases in LAC. Where only a single case of a particular result has been found, this case may reveal an important issue and pose a possible relationship between ES and sectoral output but, at this stage, can only be treated as indicative of an issue that needs to be explored.

The Role of Policy

The methodology also takes into account that costs and revenues, and markets in general, can be influenced by government policy and the actions of public agencies. The net economic benefits associated with different management practices can vary significantly, depending on the policy framework. It is well known that many natural resources are not “properly” priced or taxed by governments. Water, tree stumpage, and fishery licenses, among others, are typically underpriced. Governments still heavily subsidize agricultural activities, often with cheap agro-chemicals, energy, and credit, to favor farmers and increase food production. Such subsidies create financial incen-

tives that make conventional practices more attractive and put SEM practices at an artificial disadvantage. The Report identifies examples of such “perverse” subsidies and attempts to compare the net economic benefits of BAU and SEM practices without those incentives — as if they were altered so as to not provide incentives for natural resource depletion. This approach has led to the search for data to compare and construct, albeit loosely, correlations between management and policy practices and the economic values of ecosystems.

Box 2.1. Policy “Push–Pull” in Switching from BAU to SEM

The policy arena is typically the locus of (often protracted) struggle to close the BAU epoch and establish appropriate conditions for SEM. Even when economic and environmental conditions are ripe for change, actors with conflicting interests will push opposing policy agendas in successive areas of enterprise. A tipping point (and bone of contention) is the closure of options to externalize environmental impacts and related costs, thereby eliminating the practice of treating ES as free resources.

For SEM to thrive, a regulatory framework must emerge to level the playing field so that BAU enterprises cannot simply continue, for instance, to pollute waterways or poison downwind fields without consequence. Other policies that favor BAU in one or another aspect become issues as well, such as land tenure rules and subsidies that favor the mining of forest resources, or policies that exempt enterprises from making good on the damages caused to others.

2.2 THE ANALYTICAL FRAMEWORK - BAU AND SEM

Throughout this Report, two generic concepts are used as a basis for assessing the economic values of ES: business as usual (henceforth BAU) and sustainable ecosystem management (SEM). Having introduced those terms in the previous section, this section explains further how those two concepts are used to perceive the economic value of ES. In Part II, each sector analysis will provide a more detailed explanation of BAU and SEM as the concepts apply in each context. The decision to use the term BAU in this Report was made to simplify the analysis and presentation of findings. BAU refers not to all current activities but those that damage or deplete ES. BAU is characterized by a focus on short-term gains (e.g., < 10 years), externalization of impacts and their costs, and little or no recognition of the economic value of ES.

Table 2.1. Typical Practices Included under BAU and SEM for the Agricultural Sector
(for details on the other sectors, please read Part III)

BAU	SEM
<ul style="list-style-type: none"> • Monoculture 	<ul style="list-style-type: none"> • Agroforestry systems Multiple cropping/ greater diversity in crops Selection of crops that are more resilient to climate change (where that is a concern) Maintenance of native varieties and cultivars
<ul style="list-style-type: none"> • Intensive use of agrochemicals (pesticides, fertilizers) 	<ul style="list-style-type: none"> • Use of organic fertilizers Integrated pest management (IMP)
<ul style="list-style-type: none"> • Intensive irrigation systems with high water loss 	<ul style="list-style-type: none"> • Integrated soil and water conservation to <ul style="list-style-type: none"> • Mitigate soil erosion • Maximize rainwater harvest, conservation
<ul style="list-style-type: none"> • Land clearance resulting in loss of primary habitat and soil fertility 	<ul style="list-style-type: none"> • Low need for inputs by better fertility management

Under a SEM scenario, the focus is on long-term gains (10-20 years): the costs of impacts are internalized. Degradation of ES is avoided, thus generating potential for a long-term flow of ecosystem goods and services. SEM practices tend to support ecosystem sustainability, not for ideological reasons, but rather as a practical, cost-effective way to realize long-run profits.

Today in LAC, there are productive activities of both types in many sectors. Some activities already incorporate environmental concerns (SEM) to protect the ES that support their productive processes; others continue using ES as a free resource (input), with no concern for their degradation or depletion (BAU). Comparing the results of such experiences will provide evidence on the magnitude of the value of the ES. The differences found will be taken as an indication of the effects of the ES.

The two definitions focus on generic outcomes of BAU or SEM. Although precision may be lacking, there is consensus in each sector on steps that move in the direction of BAU or SEM. For example, though the concept SEM does not prescribe exact levels of pesticide application, it is clear that reducing pesticide overuse is a step toward SEM and away from BAU. Similarly, improved soil conservation practices in agriculture, reduced by-catch in fisheries, low-impact logging in forestry, and reduced water use in tourist hotels are all examples of marginal changes from BAU toward SEM.

BAU and SEM scenarios are constructed within each sector so that BAU and SEM management practices and their costs and benefits are presented and compared. Data is also provided on the externalities caused by different BAU and SEM management practices such

as the effect on water quality of traditional extensive livestock production versus silvo-pastoral systems, or the improvements in equity brought about by inclusion of local populations in payment for environmental services (PES) schemes.

Each chapter identifies certain SEM practices that are low in cost but can have significant economic benefits, including avoided future costs. These chapters also identify cases where BAU practices are clearly more beneficial economically and, hence, there is no economic rationale to shift to SEM. However, the economic viability of BAU is sometimes due to policy frameworks that favor the practices (subsidies), in which case an attempt is made to identify where policy change would make SEM more viable.



Data Collection

The sectoral analyses draw on technically sound economic and ecological data from published material. Available studies generally quantify a particular benefit or cost without comparing net benefit across alternative scenarios. Beside re-organization of existing data, the commissioning and development of case studies from the region was particularly important, to highlight examples

where BAU costs and SEM benefits are rising, possibly motivating a switch. The approaches of the sectoral working groups were kept similar so that findings could be harmonized.

Information extracted from existing literature was organized by sector and according to management practices and their interactions with ES and biodiversity. The majority of the literature and data is from the region. Examples from outside LAC were used when transferable or potentially applicable to LAC. The sectoral approach taken by the

Report limited, to some extent, the availability of relevant literature, since most valuation studies focused on ecosystems and not sectors.

The Report attempted to collect data on a set of economic indicators, not just income, in order to illustrate costs and benefits. These included employment generated, production output, food security, budget costs (e.g., of subsidies), tax revenues, and the impacts on low income and marginalized populations.

Throughout the Report the use of site-based examples has been central to the data collection; similarities in data findings from different locations indicate the transferability and applicability of the data across the region. Where possible, the Report identifies conditions that suggest transferability of data.

Data Limitations

The Report seeks to organize data in an innovative way, in relation to the BAU-SEM axis. The Report does not seek to generate primary research; its conclusions are based largely on existing data. Much of the Report's preparation involved finding published data that can be packaged into the desired approach. This exercise, while useful, also revealed major data limitations:



- 1) Much of the data available does not differentiate BAU and SEM management regimes, and only focuses on one particular ecosystem service (like reef biodiversity as a tourism attractant).
- 2) Few studies take a long-term perspective in which the full costs of BAU or SEM are reflected. There is little discussion on adequate discount rates for projects aimed at increasing ES provision.
- 3) There is a lack of similar studies for comparison and aggregation of data; few SEM vs BAU data sets exist.
- 4) Only a limited sample of SEM start-up activities has quantified data.
- 5) Few studies highlight the role of ES inputs vis-a-vis other factors influencing outputs.
- 6) Not many studies allow calculation of marginal changes to output from marginal change in ES.
- 7) Studies that reveal thresholds, tipping points, and risk of irreversibility of ES loss are uncommon.

2.3 POSSIBLE BAU AND SEM SCENARIOS

This section conceptualizes various ways in which sectors within a country may experience the costs and benefits associated with BAU and SEM scenarios over time. Net revenues under both BAU and SEM practices are compared graphically to show how profitability within a sector may change over time.

The graphs are generalized scenarios reflecting possible situations based on patterns that have been found. They are a point of reference for private or public decision makers to consider whether BAU or SEM is the preferable long-term course to pursue. The examples and data provided in the chapters of Part II reflect the reality of several of these scenarios, which are occurring in specific sectors in LAC countries.

The graphs also suggest the type of data needed to make an informed decision. Thus these graphic scenarios also serve to evoke a research agenda needed to fully capture ES value and compare net benefits of BAU and SEM.

Explanation of the Scenarios

Below are seven scenarios depicting how BAU and SEM may compare within sectors, depending on the causal relations between ES and sectoral outputs as well as drivers of change such as policy and market behavior. These scenarios are broad generalizations that spotlight the salient features of the BAU versus SEM comparison. With specific data, the graphs could be adjusted to capture more closely the situation of a particular sector or productive activity, or to represent other scenarios.

Each graph takes the perspective of a household, enterprise, or Ministry deciding today (time = 0) about two alternative management scenarios. The decision is focused on the net financial revenues per year for the coming years. The net revenue curves are examples that project the future from today's perspective, which is based on today's ecosystem capacities. Clearly, the curves may change as conditions evolve with time under the management scenario selected. Thus, a decision maker cannot simply wait to switch from one scenario to the other at a later point in time along the curves, taking advantage of initially favorable BAU conditions. Instead, a new curve would have to be devised at that new starting point. Once the BAU scenario has been selected and externalized costs have accumulated, a subsequent shift from BAU to SEM may become more costly or outright impossible as in the case of irreversible loss of ES.

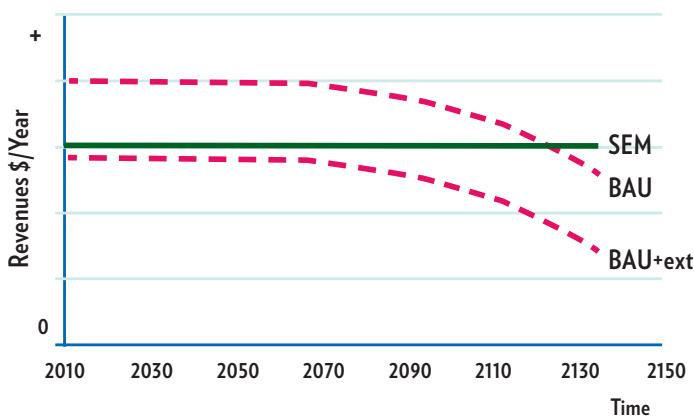
The first two graphs, Figures 2.4 and 2.5, introduce the idea of a relation between BAU and SEM that evolves over time. Figure 2.6 is about win-win situations. These are circumstances in which the BAU productive strategy has been exhausted and returns have already declined, so that a switch to SEM is immediately favorable. Figure 2.7 introduces ecosystem thresholds or tipping-points, and how these might affect net revenues. Figure 2.8 opens the door to uncertainty in net revenues, which can be very different depending on the productive scenario in use. Climate change is used to exemplify a source of uncertainty but there are many others. Indeed, uncertainty is a factor in all estimations of net revenues, but only here is it depicted explicitly. Figures 2.9 and 2.10 introduce examples of market forces and public policies.

In actual situations the decision to move to SEM and away from BAU will be clear cut in some cases. In others, the risks of ecosystem collapse will speed the decision to move towards SEM. But in most cases, this decision will require a careful analysis of discounted net benefits of both BAU and SEM strategies through modeling; decision makers will not have a single clearly superior option. Across the scenarios depicted, the BAU / SEM comparison will be context dependent, as the starting conditions and variables affecting curves like those shown in these graphs are likely to change from one situation to another.

THE BAU PARADIGM: EXTERNALIZED COSTS

In its simplest form, the paradigm shows net revenues from BAU that are either constant or start decreasing only at a late date (see Figure 2.4). Yields for the BAU model are above those of SEM for most of the planning horizon. Standard discounting of private net revenues, even if a very low discount rate is used, will favor BAU, because SEM generates more net revenues than BAU only in a very distant future.

Figure 2.4. BAU and SEM: Standard Paradigm



The case for SEM and against BAU is based on the observation that BAU may be associated with negative externalities that, if accounted for, would switch the relative advantage of each alternative. That is, though BAU might initially make financial sense from a private per-

spective (the green BAU curve running above the SEM curve), it might not make sense after externalities are accounted for (i.e., the red BAU curve running below SEM after accounting for negative externalities).

The perspective of the decision maker is all-important. A private beneficiary of the BAU net revenues would opt to follow that alternative in preference to switching to SEM, to benefit from the externalization of costs. A public servant would do the opposite. The red BAU curve in Figure 2.4 shows the net revenues from BAU from a societal perspective, after all external costs are accounted for. If, as shown, the BAU less Externalities line runs below the SEM curve, that would justify choosing SEM as the basis for public policy action. This diagram suggests the need to determine all costs (i.e., those incurred by the private decision maker as well as the hidden costs assumed by society as a whole) and benefits of BAU and SEM. A partial, merely financial analysis might be misleading.

The sectoral analysis in Part III identifies several circumstances in which curves like these in Figure 2.4 may be applicable and useful in predicting future costs and benefits for sectors in LAC:

- Tourism in areas such as Caribbean beach destinations that experience drops in visitation due to degradation of beaches, reefs, and other natural assets from over-exploitation under BAU.
- Sedimentation of hydropower reservoirs (e.g., Guri in Venezuela and Angostura in Costa Rica) due to upstream land-use change and consequent erosion under BAU.
- Decreasing soil fertility and increasing costs of fertilizer for agricultural lands under BAU cropping systems.

In each case cited, BAU enterprises remain profitable as long as the costs of ecosystem degradation can be externalized. Taking those costs into account make the SEM approaches preferable.

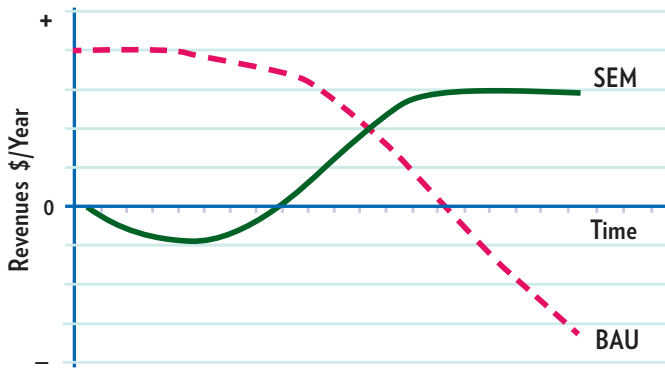
ECOSYSTEM DEGRADATION IN SHORT TERM

A different situation is captured in Figure 2.5, in which the net revenues of SEM are larger than those of BAU at a time closer to the present. In this case, BAU profits exceed those of SEM in the short run, but ecosystem degradation gradually decreases them. SEM net revenues are negative in the first years, as sunk investment costs take a toll. Although this is not always the case, sunk costs have been identified as a key hindering factor for the adoption of cleaner technologies.

Clearly, the determining factors are the size of the losses in the first years and the time needed for SEM profits to exceed those of BAU.

Note that BAU does not have to go into negative net revenues. Even if BAU profits remain positive, it could be that the discounted net profits from SEM exceed those of BAU.

Figure 2.5. Shifting Patterns of BAU and SEM Net Revenues



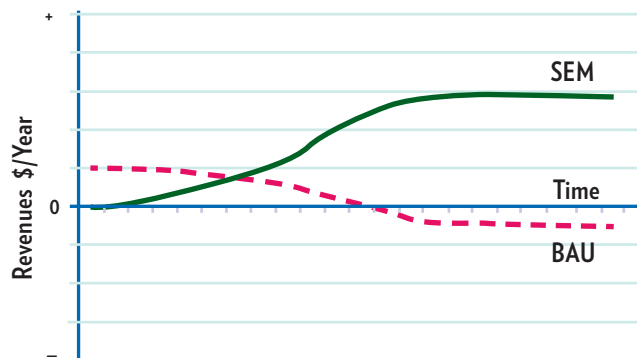
Government policies can either target the up-front costs (e.g., technical assistance) or promote a longer planning horizon (e.g., cheap access to credit).

A good example of quickly deteriorating net revenues under BAU is overharvesting of non-timber forest products (NTFP) such as Brazil nuts (Bolivia) or palm fronds (Guatemala). As the products get scarcer under BAU, pickers are forced to move deeper and deeper into the forest and to over-harvest. SEM requires investment in reorganization, training, and certification; hence, it is likely that SEM net revenues are negative in the short term.

WIN-WIN SITUATION

Figure 2.6 shows a similar situation, but one in which under BAU the productive activity cannot generate positive revenues already today. If this were a particular crop or industry, even a high discount rate will call for moving away from BAU practices, although the decision to switch toward SEM still depends on the size of the initial investment costs; as mentioned above, sunk investment costs and limited access to credit might create a strong inertia to stay under BAU even in the face of short-run losses. In the medium run, business and society as a whole will do better under SEM.

Figure 2.6. Degradation has already made BAU Marginal



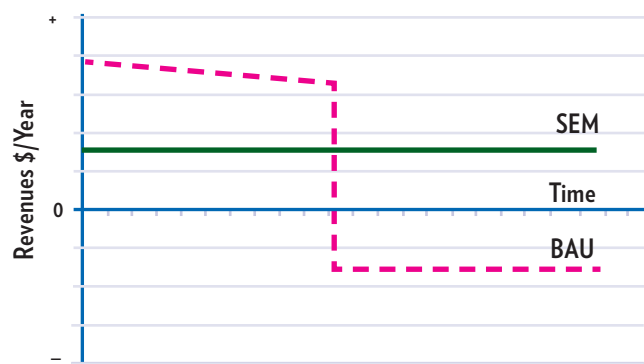
An example of this sort comes from the fisheries case study of Peruvian anchoveta, where the race to fish under BAU catch limits led to over-investment in fishing fleets, depletion of the stock, and much higher fishing costs per ton landed. The establishment of catch shares under SEM allows the fleets to reduce their size, eliminate the less efficient ships, spread the effort out over a longer period, and raise returns on investment dramatically. Modest initial investments to make the transition were required (re-training and compensation for displaced workers, and establishment of monitoring and enforcement capacity).

In other cases, small fishing boats from fisheries over-harvested under BAU have turned to guided diving and fishing tours as the SEM alternative, after initial refurbishing, training, and certification. Net revenues soon climb above what would have been earned by remaining in the fisheries competition.

ECOSYSTEM THRESHOLD AND LOST REVENUES

Figure 2.7 also shows a situation in which net revenues under BAU quickly fall behind potential net revenues under SEM. The graph depicts the potential implication of having ecosystems suddenly crash, or flip into a state where the system is no longer capable of sustaining production. As mentioned, even the risk of being near such a threshold might be sufficient to justify a move toward SEM, even if current net revenues still were higher under BAU.

Figure 2.7. Ecosystem Threshold Leads to Full Collapse



Examples of productive sectors that seem to have crossed a threshold include:

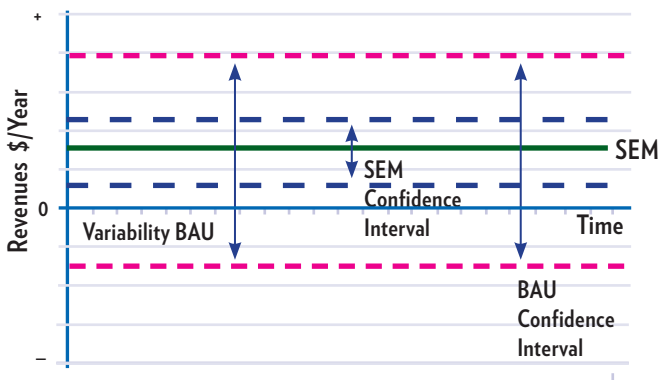
- Crop production after rainforest conversion / deforestation in marginal areas in Central America or the Amazon, where relatively high initial fertility (from decaying and burning slash) can essentially disappear after one to three harvest cycles;
- Salinization of underground water reservoirs due to excessive pumping of water for irrigation and/or urbanization;

- Collapse of banana plantations in the southern Pacific coast of Costa Rica, where build-up of fungicide residues in the soil led to collapse of fertility-related ES and of the industry itself.

UNCERTAINTY AS A FACTOR

So far, this graphical approach has served to present average net revenues across time. In the context of uncertainty, as in the face of a changing climate, working with average estimates is likely to prove insufficient, as economic agents will respond to the uncertainty by taking measures to sustain production. Figure 2.8 shows a situation in which average net revenues are larger under a BAU scenario, but subjected to much higher uncertainty. Risk averse or loss averse economic actors might favor lower uncertainty, even at the price of accepting lower expected profits. Under this constructed scenario, one would need to show that man-made and natural inputs under SEM are more resilient to climate change variation than are those under BAU. Situations of that sort are likely to arise in comparing SEM agroforestry options with higher-yielding but less diverse, more vulnerable BAU cash crop production.

Figure 2.8. Incorporation of Uncertainty

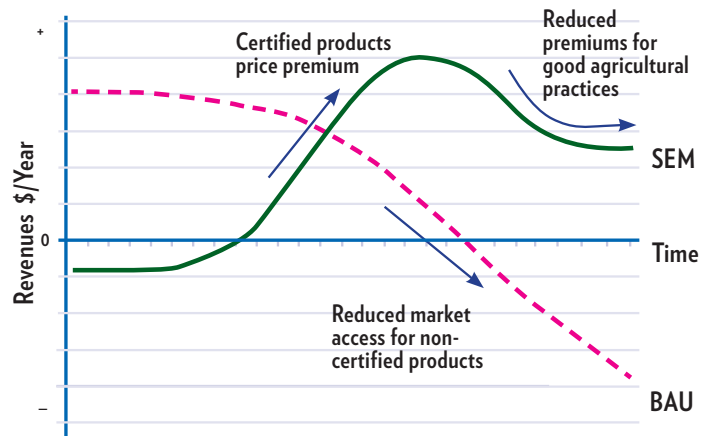


MARKET FORCES

The previous scenarios have highlighted ecosystem deterioration as the main reason for faltering net revenues under BAU. Yet market forces — for example, a shift in consumer preferences toward “green” products — can also change the nature of the BAU/SEM trade-off. Figure 2.9 depicts a situation in which consumer preferences for certified products raise the revenues of goods produced under SEM, but only up to a point, after which the market premium is reduced and certification becomes a market access requisite. High premiums can still be observed for certified organic vegetables and fruits, but in the case of certified timber, the market is already more likely at the latter stage of the graph. Revenue increases also stem from gains in efficiency from better farming practices. BAU net revenues have fallen because demand and prices for non-certified produce have dropped.

METHODOLOGY OF ECONOMIC ANALYSIS

Figure 2.9. Changing Consumer Preferences: Market Forces Raise Relative Advantage of SEM

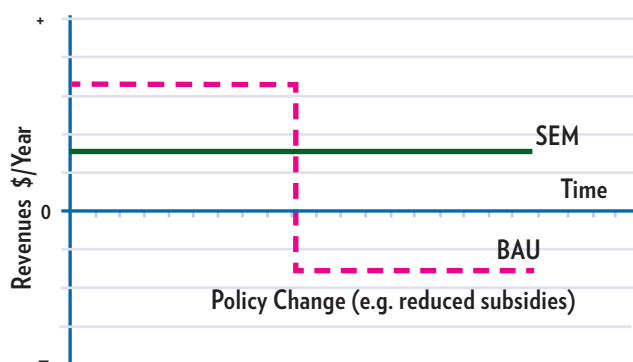


INTRODUCING POLICY INSTRUMENTS INTO THE CONSTRUCTED SCENARIOS

This far, these graphs have presented situations in which net revenues under SEM or BAU are associated with ecosystem deterioration or private investment decisions.

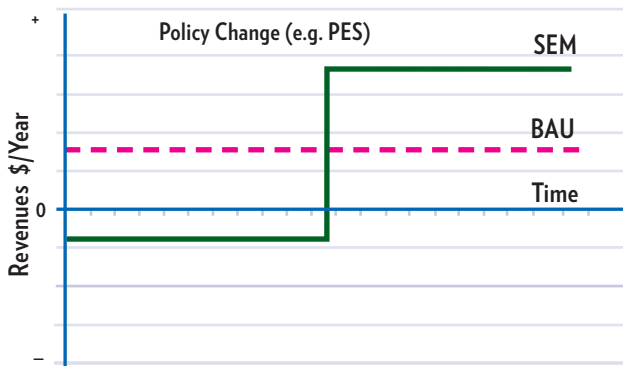
Clearly, governments can create incentives and other conditions to change the balance in favor of BAU or SEM. For example, Figure 2.10, Policy Change: Discouraging BAU, shows a situation in which a policy is introduced that lowers the profitability of BAU. This could be the elimination of “perverse” subsidies that favor BAU practices (like subsidies for purchase of fuel or fishing ships in over-exploited fisheries, or subsidized agrochemical products for industrial cropping schemes). Other examples include introduction of pricing of natural resources as inputs into productive activities or the use of green taxes to correct for negative externalities (e.g., a tax on emissions, elimination of fuel subsidies for fishing boats in the Galapagos).

Figure 2.10. Policy Change: Discouraging BAU



An alternative strategy would be to encourage SEM with the use of policies that raise the profits of cleaner or more sustainable management strategies, or that facilitate transition to them. A well-known example is the use of payments for ES, and of subsidized access to credit that leads to green investments. Figure 2.11 captures this situation.

Figure 2.11. Policy Change: Encouraging SEM



For example, Brazil introduced in February 2010 a favorable credit line focused on restructuring the tourism industry to move from BAU to SEM. This policy can trigger a shift in the relative net revenues of SEM and BAU, favoring SEM.

2.4 INFORMATION, UNCERTAINTY, AND IRREVERSIBILITY

Certain ecosystems exhibit fast, unpredictable, and sometimes irreversible changes. There is a lack of knowledge about biodiversity and ecosystem functioning and the importance of ES. As new information enters the cost-benefit analysis of SEM versus BAU, it is possible that the balance between them will be changed. Unfortunately, if some ecosystems are being irreversibly lost to development under the BAU scenario, it may be impossible to make a change to SEM by the time the evidence to support change arrives.

Secondly, comparisons between BAU and SEM may become complicated if the quality of ecosystems and their services were to change abruptly in the face of increasing pressure, as their capacity to be resilient becomes strained. Ecosystems are, typically, characterized by thresholds beyond which the system flips into an alternative, usually unproductive, state (e.g., desertification). Most ecosystems can sustain spells of water shortage without losing their capacity to generate ES or to rebound once water reappears. But if a threshold of water supply is crossed, the ecosystem may become a desert, with changes that make it impossible or extremely costly to revert to the system to an original state, even if water becomes abundant. Global warming provides other examples of changes that occur in a non-linear way.

As the limits of natural ecosystems are pushed to extremes, more data is appearing on benefits associated with SEM and costs arising from BAU. Global warming, and deforestation in the Amazon are cases in point that need to be analyzed from the perspective of uncertainty about net benefits of alternative scenarios, tipping points, and irreversible change.

CHAPTER 3.

ROLE OF BIODIVERSITY AND ECOSYSTEMS IN ECONOMIC GROWTH AND EQUITY

Andrew Bovarnick⁷ and Francisco Alpizar⁸

This chapter explains economic growth and equity patterns in LAC, the economic role of the sectors analyzed, and the role of ES for those sectors. Hence, the chapter outlines the role of ES for LAC economic growth and equity. The chapter then goes on to frame the drivers of ES loss, and the role of governance and markets to influence economic activities affecting ES.

3.1 OVERALL TRENDS IN ECONOMIC GROWTH AND EQUITY IN LAC ⁹

ECLAC estimates that, after six years of continuous growth, the GDP of Latin America and the Caribbean fell by 1.8% in 2009. This drop meant a decrease in per capita GDP of 3.1% and will take its toll on the labor market. The social impact of the current global crisis on the countries of Latin America varies greatly. Effects include a rise in unemployment and informal employment, and in poverty, indigence, and risk of falling into poverty, with problems in sustaining the expansion of social spending. The region's unemployment rate is expected to climb from 7.5% in 2008 to around 9% in 2009.

The region is, nonetheless, better positioned to respond to the crisis than in previous economic downturns. This is due not only to its own efforts at prudent fiscal management and inflation control, but also to the fact that in 2002-2008, the region benefited from a favorable international economic situation. This has dramatically changed. Poverty levels, social spending, and income distribution may suffer as a result.

The poverty rate among the region's population was 33% (180 million) in 2008, including 13% (71 million) in extreme poverty. The

decline in the poverty rate from 2007 to 2008 — 1.1% — is notably smaller than the 2% average annual decrease from 2002 to 2007. Higher food prices, which led to a rapid increase in the cost of the basic food basket, were the main reason for worsening extreme poverty.

However, overall current figures are an improvement with respect to 2002 and the two previous decades. Not only are the current poverty rates far below those recorded in 1990, but, in absolute terms, the number of poor has fallen by 20 million. Between 1980 and 1990, the poverty rate also declined considerably, albeit to a degree insufficient to completely offset the high rate of population growth during that period.

The slowdown caused by the international crisis is affecting the dynamic of LAC economies in the global context. Weaker demand for goods exported by the region and a reduction in migrant remittances are factors that will tend to undermine aggregate demand in the region's countries, and thus threaten the progress in poverty reduction attained. In economies where employment and earnings of lower-income households are set to decline, poverty and indigence could also rise. Any such increase, though modest, would prolong the negative trend that began in 2008, ending a five-year period of declining poverty.

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⁸ Coordinator and a Senior Research Fellow, Environment for Development Center, CATIE.

⁹ ECLAC contribution prepared for this Report (2010).

Regarding equity, while the region remains exceedingly unequal, indicators reflect the decline in inequality that predominated in several countries between 2002 and 2007. The Gini index improved by an average of 4% during that period. Seven countries saw significant diminution in the Gini: Argentina, Venezuela, Nicaragua, Peru, Panama, Paraguay, and Bolivia. The only countries where income concentration increased during this period were Colombia, the Dominican Republic, and Guatemala.



A longer-term comparison shows that current inequality levels are the lowest recorded since the early 1990s. Despite that progress, income concentration in Latin America remains among the world's highest.

Box 3.1. Global Economic Recession and Drivers of Ecosystem Management

Effects of the financial crisis on ecosystem protection are not clear, depending on several factors that interact in opposite directions. On one hand, a dip in fiscal revenues (in LAC and especially in developed countries) will lower the availability of funds for environmental protection and natural resource management, both domestically and internationally. Public-sector environmental budgets fluctuated widely in the 1990s. The situation is compounded by a certain degree of fragility and a lack of continuity among environmental institutions. Generally speaking, deficits and the need to generate funds to meet external obligations have led to budget cuts that impinge heavily on environmental results (ECLAC-UNDP 2002).¹

On the other hand, economic slowdown and the consequent reduction on commodities demand from developed countries diminishes pressures on environment, especially those related to deforestation for expanding agricultural and livestock activities.² During the first semester of 2009, exports of agriculture products dropped by 17%. In the same period, the value of total regional exports fell by 31% compared with 2008, with a 15% decline in volume and an 18% drop in prices (ECLAC 2009b).

¹ For example, during Argentina's 2001 economic crisis, public environmental spending cuts reached 43%.

² As a result of the global financial crisis, GHG emissions of developed countries show significant reductions.

Box 3.2. CBD Definitions

Biological diversity is the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Ecosystems are a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

(Article 2 of the **Convention on Biological Diversity**)

3.2 IMPORTANCE OF NATURAL RESOURCE-BASED SECTORS IN LAC ECONOMIES

This section provides a brief description of the sectors analyzed in this Report and their respective importance in the national economies and in LAC. The sectors analyzed are those with a high dependence on renewable natural resources and, hence, on biodiversity and ecosystems.

Agriculture: Across the region, the agricultural sector makes significant contributions to GDP, export revenues, employment, and rural livelihoods. Its contribution to GDP over the period 2000-2007 averaged 9.6% for the region, while agricultural exports represented 44% of the region's total export value in 2007. For some countries, agriculture exports were more than 80% of total commodity exports (for example, Panama, Paraguay, and Nicaragua). Important export crops for the region include bananas, soybean, coffee, and beet sugar. Around 9% of LAC's population is employed in the agriculture sector and agriculture is a primary source of income for rural households.

Fisheries: The fisheries sector is economically important in LAC, contributing to GDP, food security, employment, domestic income, foreign exchange earnings, and fiscal revenues. In absolute terms, Chile, Mexico, Colombia, and Brazil each derived more than \$2 billion from fisheries; Venezuela, Panama, Argentina, Guyana, and Peru more than \$100 million in 2004 (Catarci 2004). In relative terms, fisheries are important at the national level in a wide range of countries in LAC, contributing more than 1% of GDP in at least 10 countries. Fisheries are especially important to the livelihoods of the poor in coastal regions.

Forestry: On average, logging and related processing activities in LAC contribute 2% to GDP. From 1990 to 2006, the forestry part of GDP in LAC rose from \$30 billion to \$40 billion, most of it from roundwood production. In terms of job generation, FAO (2008) put the number of people employed in the roundwood, and pulp and paper and wood processing activities at 1.5 million in 2006, or 0.75% of total employment in LAC. The region is home to the Amazon, the world's largest rainforest and most biodiverse biome, and to other kinds of tropical and temperate forests, savannas, and semi-arid biomes. Besides their direct contribution to GDP, forests have substantial potential to generate ongoing economic production based on ES from water to food, fiber, carbon sequestration, non-timber forest products (NTFP), and tourist attractions.

Tourism: The contribution of the tourism sector to GDP for LAC as a whole ranges from about 2% in the larger countries of South America to almost 20% in the Caribbean, with Central America ranging in between. Growth rates in LAC averaging 8% have consistently outstripped North American and global growth rates for 15 years. The Caribbean, with a reputation for conventional BAU tourism, has seen growth rates dip in recent years. The sector is a major employer, especially in the Caribbean, where it absorbs from 5% to 19% of the workforce.

Protected Areas: Terrestrial and marine reserves provide crucial ES to each of the sectors above. These services include provision of clean water for irrigation, hydropower, and urban consumption; no-take zones from which biodiversity can re-build and species heavily fished or hunted can re-stock nearby areas; and income options from forestry concessions, fees and taxes, and payment of environmental services. Growing green markets are opening significant opportunities to protected area (PA)-related business. Via nature-based tourism, PAs have brought jobs, local development, and prosperity to remote sites, while contributing to GDP, tax revenues, and foreign exchange earnings. Under SEM, PAs can drive poverty alleviation and equity: women, rural communities, and indigenous peoples have been afforded opportunities to build self-sufficiency.

Hydrological Services: Water is not a formal economic sector; yet, access to clean, secure water supplies and their use in hydropower generation provides vital inputs to households, industry, farmers, and ecosystems. This underpins economic development as well as human health and quality of life. A reliable, high quality water supply is vital to the region's industrial competitiveness. Low cost water from natural flows and built storage facilities enables farmers to provide a large range of agricultural products for local and commercial use. Finally, clean and abundant water in streams, rivers, and lakes provides critical habitat and support functions for aquatic biodiversity and wildlife, which in turn contribute to growing tourism and recreation activities. Maintenance of these hydrological services is critical to SEM.

3.3 DEFINING BIODIVERSITY AND ECOSYSTEM SERVICES

The sectors analyzed depend on renewable natural resources. They generate outputs—food crops, wood products, fish harvests, hotel occupancy, and tourism revenues, among others. These sectoral outputs absorb inputs of many sorts. Many are human-made: capital construction, goods like fertilizers and pesticides, technologies, and knowledge.

Other inputs are natural in origin, generically called ecosystem services (ES). (Types of ES are discussed below.)

Biodiversity is central to the health of most ES and plays a key role in maintaining ecosystem resilience, defined as the capacity of an ecosystem to return to its original state following a perturbation. From an anthropocentric perspective, resilience is the capacity of a system to sustain a shock and still retain its basic capacity to provide ES that are fundamental to human well-being (Holling 1973; Walker and Salt 2006). The more biologically diverse the system, the higher the availability of alternative structures and functions that can shore up or replace those weakened after a shock, ensuring continuity of ES.

Box 3.3. The Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MA) was initiated in 2001, following a call by the United Nations Secretary-General Kofi Annan. Its objective was to “assess the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being” (MA 2005b).

The MA drew upon existing scientific literature and the expertise of more than 1300 experts from over 70 nations, and was the first attempt by the scientific community to describe and evaluate the full range of services derived from nature. The ecosystem service assessments cut across sectors, included perspectives from natural and social sciences and were undertaken at both a global and sub-global level (SGAs); SGAs included local, national, and regional studies. Its intended primary users were the international ecosystem-related conventions, regional institutions, UN agencies, national governments, civil society, and the private sector (Wells, Grossman, and Navajas 2006).

The MA found that 60% of 24 ES investigated were being degraded, and as few as four were increasing in their ability to promote human well-being. More worryingly, the as-

assessment identified an increasing likelihood of non-linear, i.e., accelerating or abrupt change within ecosystems, for example, disease emergence, surfacing of uncontrolled pest populations, the collapse of fisheries, dead zones in coastal waters, and regional climate change, to name a few (Wells, Grossman, and Navajas 2006). The implications of that kind of change for human well-being are uncertain.

Overview of Ecosystem Services

The Millennium Ecosystem Assessment (MA 2005a) provides a framework to assist in identification of ES. The list includes provisioning services such as food chains, water, timber and NTFPs; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling. ES are derived from the native and managed biodiversity of a region. Typically, in order to be considered a service, a flow of resources must result directly or indirectly in greater human welfare. Conceptually, healthy biodiverse ecosystems generate greater amounts, higher quality, and more stable flows of ES over time. Figure 3.1 highlights the linkages between ES and human well-being.

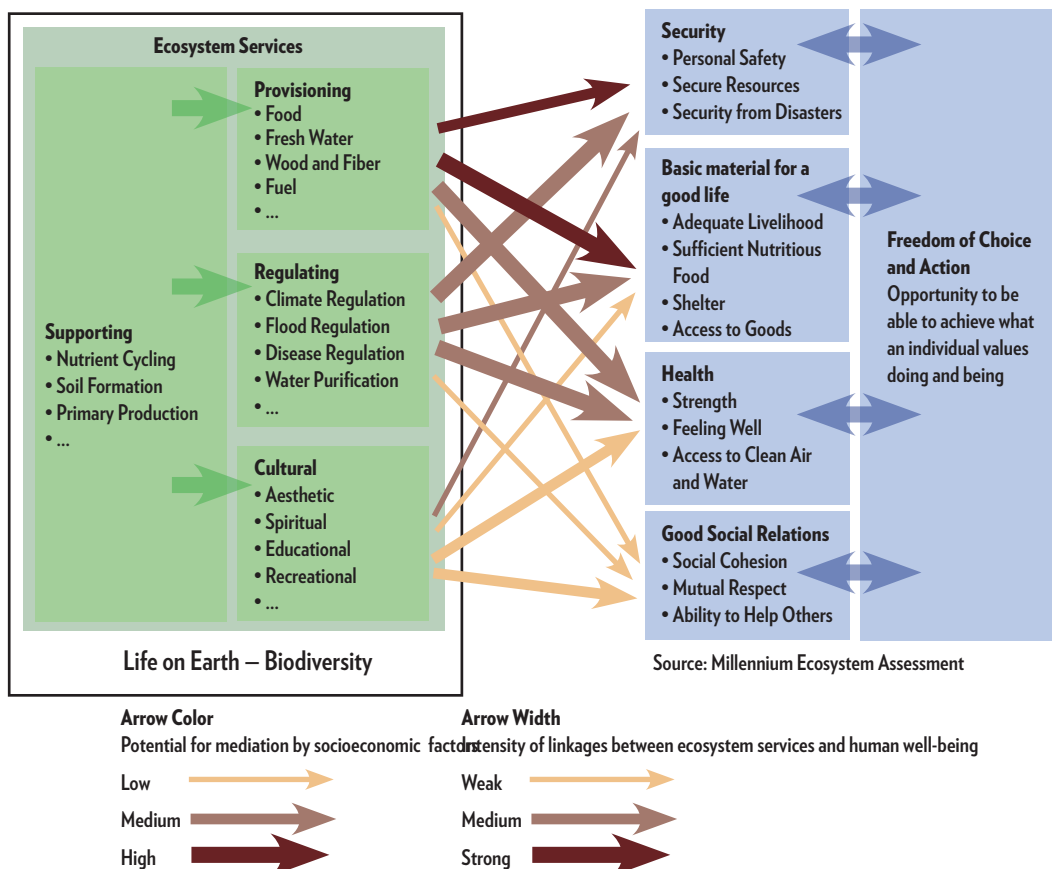
The primary activity of many of the sectors analyzed in Part III is to manage human-made ecosystems (e.g., a forest or sugarcane plantation, a fisheries stock, or an artificial reef) to maximize production of timber, food, fiber, tourist visits, and other biologically-based economic production systems, large and small. In the process, they depend on a variety of supporting and regulating services, such as soil fertility, pollination, and natural pest control (MA 2005a; NRC 2005). These supporting and regulating services determine the underlying biophysical capacity of man-made ecosystems (Wood et al. 2000). ES, thus, serve as inputs to productive sectors. Some of these services can be substituted for by human-made inputs (e.g., fertilizer, flood mitigation works). However, in some cases no substitution is possible, making these ES not just inputs, but irreplaceable “life support” facilities for productive activities.

The following sections summarize the types of ES provided to and by the sectors discussed in this Report.

Provisioning

Provisioning services are of two sorts: 1) the products people obtain directly from ecosystems — often artificial ones — such as food, fuel, fiber, fresh water, and genetic resources (MA 2005a); and 2) natural provisioning of inputs to economic production systems, which

Figure 3.1. Biodiversity, Ecosystem Services, and Human Well-Being



provision humans indirectly but directly underlie their productive capacities. Examples of this second kind are the food chains that supply fisheries stocks, precipitation that grows crops, and natural viewscapes that attract tourists. Maintenance of both kinds is vital to human welfare.

Regulating Services

Regulating services are those obtained from the balance of ecosystem processes, in both natural and artificial ecosystems. They include air quality maintenance, climate regulation, erosion control, restraint of pests and diseases, and water purification (MA 2005a). Regulating services are perhaps the most diverse class of ES; they are provided to and by both human-made and natural ecosystems. Productive landscapes are affected by and contribute to the population dynamics of pollinators, pests and their enemies, pathogens, and wildlife and other non-timber forest products, as well as by fluctuations in soil loss, water quality and supply, greenhouse gas emissions, and carbon sequestration. Some examples:



Storm mitigation and flood regulation is an ecosystem service that involves all sectors, from agriculture and forestry to tourism and PAs. Agricultural land and forests can alleviate flooding by storing waters and retarding out-flow, or conversely magnify damage if soil erosion increases sedimentation and compaction decreases infiltration and increases down-slope flow rates, contributing to local flooding and risk of downstream disasters. Similarly, surrounding landscapes such as upstream forests, coastal mangroves, and PAs absorb and disperse storm energy and provide flood regulation service to many sectors. Poor management of agricultural lands and supporting landscapes (such as headwaters and wetlands) can contribute to the loss of crops and infrastructure. Hydropower and irrigation infrastructure is vulnerable to sedimentation, as are coral reefs and other key habitats.

Climate regulation is an ES critical to agriculture, forestry, and fisheries. Favorable temperature and precipitation regimes (microclimates) confer advantages to farms; stable conditions are important for long-term tree plantations and fish stocks. Tourism areas also rely on favorable climates. Continuity of suitable, stable climates relies on atmospheric regulation that is influenced by the functioning of ecosystems.

Pest and disease regulation: Bacteria, fungi, arthropods, and vertebrates are important both for the damage caused by some and the vital pest and disease control services provided by others. They decompose waste, recycle nutrients, reduce contagion, suppress pest damage, and improve yields, while contributing to long-term ecological equilibria that slow the emergence of new pests (Zhang et al. 2007).

Supporting Services

Supporting services are those necessary to produce other ES, such as primary production, liberation of oxygen, and soil formation (MA 2005a). Supporting services include soil structure and fertility, pollination, nutrient cycling, primary production, and the growth and reproduction of living organisms.

Soil structure and fertility: Soils are increasingly recognized as a multi-functional resource that provides additional ES such as drinking water purification, biodiversity, a CO₂ sink, and other services (Montanarella 2008). ES derived from soil formation relate to the maintenance of crop productivity on cultivated lands and the integrity and functioning of natural ecosystems (de Groot et al. 2002).

Pollination is most important for agriculture but also for forestry. Production of 75% of the world's most important crops and 35% of the food produced depends on animal pollination (Klein et al. 2007). Pollination from natural vectors improves productivity, and, in some cases, the quality of the product.

Nutrient cycling: Agriculture and forestry depend on continuous recycling of 30 to 40 chemical elements. Many aspects of natural ecosystems facilitate nutrient cycling at local and global scales. For example, soil organisms decompose organic matter, releasing nutrients to plant growth, to ground water, and to the atmosphere. Migration of insects, birds, fish, and mammals helps move nutrients among ecosystems. ES derived from nutrient cycling are related to soil maintenance, primary production, and to regulation of gases, climate, and water (de Groot et al. 2002).

Primary production, growth, and reproduction: Energy capture, performing the chemistry of living things, and growing and reproducing populations of target species — be they crops, trees, fish stocks, or other — is the basis for all economic production from biological natural resources.

Box 3.4. The Role of Ecosystem Services and Biodiversity in Adaptation to Climate Change Strategies¹

Much attention has been given to the functional role of biodiversity in production and supporting services, but in terms of adapting to climate change, the focus must turn to regulating services.

Most climate change models predict an increasing severity of weather events in the form of storms or droughts, depending on location. The greatest concern for human society should be to understand how the regulating services

es of biodiversity can be harnessed to reduce the impacts of these extremes. Ecosystems provide essential regulating services that lessen environmental uncertainty, and improve resistance and resilience to disturbances. Stability — ecosystem-level homeostasis — is a product of multiple ES that will increase in importance as the impact of climate change becomes manifest. The relation between biodiversity and stability is called the portfolio hypothesis in light of its similarity to diversified financial portfolios. Adaptive biodiversity means not only preserving current ES, but conserving reserve species that may emerge in case key species are lost with climate change.

Hurricanes provide an excellent example of the role of ES in adaptation to climate change. Increasing storm frequency and intensity is predicted as a primary effect of climate change, with potentially devastating impacts on Central America and the Caribbean. Hurricane Jeanne hit Haiti in September 2004 with more than 2000 dead and missing, whereas the adjacent Dominican Republic fared much better. Haiti, originally deforested for coffee and sugar cane monoculture, exemplifies ecosystem collapse with only 3% of its land under forest cover, compared to 28% in the Dominican Republic. No natural ecosystems were left to buffer the impacts of the hurricane in Haiti. Developed countries are no less immune from such concerns. Hurricane Katrina dealt a large social, economic (estimated by some at >\$82 billion), and political blow to the U.S. In both cases strategically located and managed ecosystems, forests in Haiti, and mangroves in Louisiana, could have played important roles in reducing the impacts of these now predictable events.

¹ Fabrice DeClerk, CATIE.

3.4 BIODIVERSITY AND ECOSYSTEMS IN LAC

Latin American and Caribbean countries are among the world's richest in biodiversity. The region includes five of the world's ten most biodiverse countries — Brazil, Colombia, Ecuador, Mexico, and Peru — as well as the single most biologically diverse area in the world, the Amazon. South America alone has more than 40% of the Earth's biodiversity, and more than one-quarter of its forests. The Meso-American Reef is the largest coral barrier reef in the Western Hemisphere. Central America, with only 0.5% of the world's land mass, has 10% of all of its biodiversity. Forty percent of the plant life in the Caribbean is found nowhere else on earth. These numbers are impressive; in particular when taking into account that the

region represents only 16% of the global land surface and has only 10% of the total human population (Bayon, Lovink, and Veening 2000) (FAO statistics).

However, these resources are being depleted. Caribbean coral reefs have been reduced by 80% in three decades (UNEP 2008). Deforestation rates in Central America are higher than anywhere else in the world (FAO 1997). Brazil, Colombia, Peru, Ecuador, and Mexico are among the countries with the world's highest number of threatened terrestrial vertebrates. More than 80% of commercial fish stocks in the South Western Atlantic and 40% in the South Eastern Pacific are fully fished, overfished, or depleted. As much as 65% of mangrove forests, important for flood protection and for the productivity of many fisheries, have been lost in Mexico over the last 20 years; 55% of the region's entire mangrove coastline is now classified as in critical or endangered status (Lemay 1998).

Today, ecosystems throughout the LAC region are generally in worse shape than in previous decades. This means that ecosystem resilience — their capacity to adapt and sustain external shocks — is continually reduced, at the same time as the world is faced with climate change and its far reaching implications. There are limits to the natural resource abundance that has so far represented an important competitive advantage for LAC. Key ecosystems are close to systemic failure, with important implications for agriculture, fisheries, logging, and water supply, among others.

3.5 BIODIVERSITY AND ECOSYSTEM'S ROLE IN SECTORAL GROWTH IN LAC

The links between biodiversity and ES and economic growth in LAC are many. The sustainable use of biodiversity contributes to economic growth through the impact that biodiversity and ES has on productivity. The following examples from Part II of this Report provide background to this claim. They will be further supported in each sector chapter.

Agriculture: About 73% of water withdrawn in LAC is devoted to agricultural production; 8.5 million ha of crops in the region require irrigation, making management of water resources critical to the viability of the agricultural sector. Pollination is another key service provided by nature, with around 35% of crops worldwide supported by natural pollinators. Many ES are, in effect, free inputs into agriculture production. If damaged or lost they need to be replaced by human-made interventions that can act as substitutes (e.g., loss of soil fertility may be compensated by increased use of fertilizers). However, some ES such as supporting services (e.g., nutrient cycling, pest regulation and pollination) cannot be substituted for by

human-made capital. These ES underpin all other ES; without them, systems are liable to grow economically unviable.

SEM can both harness ES and provide higher returns to farmers than more traditional farming systems. The ecological benefits associated with agroforestry include carbon sequestration, biodiversity protection, soil improvements, crop pollination, and water provision. A World Bank study of agroforestry systems across Central America (Current et al. 1995), found that profitability is dependent on the site, resources, and markets. Of the 21 systems analyzed, 40% had significantly higher returns than traditional systems. For example, one agroforestry system had a net present value (NPV) of \$2,863/ha (over 10 years, 1992 values) compared to \$1,423/ha for contour planting and \$764/ha for woodlots. Only 10% performed less well than traditional systems. However, in this and other SEM agricultural systems, incentives and technical assistance are usually needed to promote uptake, since returns can lag in the early years until trees mature.

Forestry: Forest plantations require a healthy environment to flourish. The production of ES by natural forests and plantations provides virtuous feedback cycles of higher productivity for the forestry industry. If natural conditions around forests are not adequate and ES are degraded, forests and plantations may lose productivity. Productivity in healthy forests also reflects the quality and quantity of ES provided. This is seen, for example, via basic timber productivity, but also in extraction of NTFP that can become a substantial source of income for forestry entrepreneurs. This is especially true in the case of community-based forest enterprises. Examples include mushroom collection in Mexico; botanicals, medicinals, and fibers in Mexico and Guatemala; and brazil nuts in Bolivia and Brazil. Sales from such ES-based NTFP in some cases have reached 10% of timber income (Scherr et al. 2004).

In addition, natural forest cover in riparian areas near forestry plantations may provide a buffer against floods that have the potential to undermine productivity. For example, the riparian areas associated with river and stream floodplains act as water storage areas that can significantly reduce the height of floods downstream and can help reduce flood velocities.

Many forest species are dependent on animal pollination in order to set seed. Pollination services can be generated in small patches of natural forest in human-dominated agricultural landscapes. The best known pollinators are insects, as well as some bats and birds. In the case of Iwokrama Forest in Guyana, animals also play a fundamental role in seed dispersion. Of 172 Guyana Shield timber species, 51% were mammal-dispersed and 21% bird-dispersed (ITTO/UICN 2009). Fish and iguanas also disperse tree seeds. Thus, tropical forest management under SEM will owe its success to a wide range of wildlife-based ES.

Fisheries: The pattern of marine fisheries development in LAC parallels that in the rest of the world. Marine capture fisheries production has probably reached a plateau, despite increased fishing capacity. Further development is likely to be achieved by rebuilding depleted fisheries, restoring critical habitats, and increasing economic efficiency. Recognizing this, a number of countries have started to reorient their fisheries toward SEM. The goal of SEM in fisheries is to generate optimal, sustainable yields while safeguarding the capability of ecosystems to provide the ES on which fisheries-based and other economic activities depend. Maximizing economic rather than biological yields will generally require larger stock biomass, so economic and ecological objectives point in the same direction (Grafton et al. 2006).

Today, ecosystems throughout the LAC region are generally in worse shape than in previous decades. This means that ecosystem resilience — their capacity to adapt and sustain external shocks — is continually reduced, at the same time as the world is faced with climate change and its far reaching implications.

The foundation of SEM in fisheries is the responsible management of single species and multi-species fisheries. Addressing larger issues of ecosystem health, habitat preservation, and impacts on non-commercial biota will depend on achieving responsible management.

A major challenge for LAC is that many economically important fisheries are characterized by large numbers of small vessels out of numerous small ports targeting multiple species. The tools that have been developed for industrial fisheries management are less well-suited to these small-scale fisheries, some of them community-based. Several countries in LAC are, therefore, pioneering new approaches for the responsible management of these fisheries. Globally, much greater attention needs to be paid to the particular challenges of small-scale fisheries management and to developing a set of tools that are effective in these contexts. Some such tools are being tested in LAC; examples include community co-management, territorial use rights in fisheries, and individual transferable quotas, among others.

Tourism: The tourism sector, including both the conventional recreational sun and sand category and the burgeoning nature-focused

type, are highly dependent on healthy biodiversity and maintenance of ES. This dependence is manifested by the provision of drinking water, clean beaches, healthy reefs, freshwater, birdlife, fish, whales, forests, and other features used as attractions to drive demand. Current growth of recreational and nature-focused tourism and their long-term potential in LAC is undermined by a degradation of these resources and services.

Protected Areas: Under BAU, PA systems tend to be not well defined, and are poorly protected and severely underfunded. Typically, coverage is too scant to preserve a representative sample of the country's biodiversity; ecosystems within the parks are often being altered and degraded. To build on existing opportunities requires shifting toward sustainable management, facilitating nature-based tourism, NTFP exploitation, payment for environmental services, or other sustainable enterprises in PAs that can bring jobs, growth of local service providers, and a modicum of prosperity to remote sites.

Hydrological Services: It is clear that land management — whether production-focused BAU conversion of forest or less intensive SEM practices — will impact the hydrological cycle and affect the quality, timing, and abundance of downstream water supplies. Decades of research have confirmed the importance of maintaining intact ecosystems to reduce impacts on water quality downstream. Land-use change can have a variety of impacts on downstream water supply, thus, sustainable watershed management involves not only efforts to protect ecosystems upstream, but also efforts downstream to manage human use and infrastructure development.

On intact headwater catchments in LAC, the risk and potential cost of land-use change in terms of degrading downstream water quality argues for the maintenance of ES and expenditure in ecosystem protection. The benefits of this expenditure come in the avoidance of potentially large and near-term costs to water infrastructure—for water treatment, irrigation and hydropower. They take the form of avoided operational and maintenance expense, and postponed investment in additional infrastructure. Thus, risk aversion is the primary concern in intact headwater catchments; SEM should be maintained to protect downstream economic uses of water and physical infrastructure.

3.6 BIODIVERSITY AND ECOSYSTEM'S ROLE IN EQUITY

In LAC, close to a fourth of the population lives on less than \$2 a day; in rural areas, 55% of the population has no access to improved water sources (WHO-UNICEF 2009). It is the poorer members of society, those unable to afford substitutes during times of crisis or degradation, who rely most heavily on biodiversity and ecosystem goods and

services. Indeed, biodiversity provides a primary safety net for rural populations in the LAC region and is one of the few factors limiting malnutrition and large-scale urban migration. Degradation and loss of biodiversity and ES hinder the ability of these groups to cope with environmental change, pushing them further into poverty.

An effective strategy to reduce poverty cannot be designed in isolation from its environmental context, and needs to promote sustainable resource use and management strategies by the poor. Evidence is presented in this Report to show that the objectives of reducing poverty and inequity, and maintaining ES are not contradictory but, indeed, complementary. This follows at least three patterns. First, the externalized impacts and costs generated under BAU often affect most strongly the poor and vulnerable populations. Second, creation of jobs and other opportunities under SEM take place mainly in rural areas, where impoverished populations are concentrated. Evidence from each of the sectors reflects improved access to income-generating opportunities by those groups. Finally, the increase in consultation with stakeholders, beneficiaries, and other local actors that characterizes SEM (required to avoid creating externalities) offers poorer and marginalized groups better information, access to decision making, and more empowerment in general, as the circle of participants is widened (e.g., to include women, youth, indigenous peoples, and other minorities).

3.7 BIODIVERSITY AND ECOSYSTEM SERVICES LOSS IN LAC¹⁰

Across Latin America, the ongoing loss of biodiversity and deterioration of ES is being driven by a complex set of interlinked factors. The immediate drivers of biodiversity loss and ecosystem degradation include: 1) habitat loss, conversion, and alteration (e.g., due to logging, fires, fragmentation); 2) overharvesting or unsustainable use of terrestrial and aquatic resources; 3) unsustainable land management practices; 4) contamination of terrestrial and aquatic ecosystems from intensive economic activities; 5) the spread of alien, invasive species that impact the structure and functioning of ecosystems; and 6) climate change. Of these, the loss of natural ecosystems and their conversion to productive systems is currently the most important driver of biodiversity loss and ecosystem degradation, with an estimated 4 million ha/year of tropical forest cleared in South America (FRA 2010).

These proximate drivers of biodiversity loss and ecosystem degradation, in turn, are driven by a combination of underlying demographic, social, political, economic, market, and cultural forces. For example, rapid population growth in Latin America puts ever-increasing pres-

¹⁰ Invited section by Celia A. Harvey, Conservation International.

sure on both terrestrial and aquatic ecosystems for food, fiber, water and other goods, as do changing lifestyles and rising incomes. Social factors, such as increased migration to urban areas, insecure land tenure, colonization of remote areas, increased social inequality, and growing poverty, among others, can also lead to the changes in the consumption and exploitation of natural resources.

Box 3.5. Millenium Assessment Results

Three main findings (MA 2005a, p. 1):

- Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber, and fuel. This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth.
- The changes that have been made to ecosystems have contributed to substantial net gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many ecosystem services, increased risks of nonlinear changes, and the exacerbation of poverty for some groups of people. These problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems.
- The degradation of ecosystem services could grow significantly worse during the first half of this century and is a barrier to achieving the Millennium Development Goals.

In general, marginalized populations depend more heavily on natural resources for their livelihoods and are more vulnerable to changes in the provision of ES. In addition, many governments fail to recognize the value of biodiversity and ES, and do not incorporate these values into decision-making processes, such as national and sub national policies, economic and fiscal incentives, sectoral policies, and governance issues. As a result, government policies often inadvertently promote environmental degradation or subsidize unsustainable activities (such as the replacement of primary forests with biofuels or cattle production, or the removal of mangroves for shrimp production) that degrade natural ecosystems and diminish their ability to provide ES.

In addition, many countries lack appropriate legislation to conserve biodiversity, ensure sustainable natural resource management, and avoid overharvesting of natural resource products. Even where such legislation exists, there is often limited capacity or willingness to enforce these rules. Other social factors that threaten biodiversity and ES include poor governance, corruption, government instability, and war and conflicts. Economic forces—such as growing markets

for agricultural products and natural resources, increased commercialization, changes in market prices for natural resource commodities, globalization, and a demand for rapid financial profitability—are also driving resource use patterns, often with negative impacts on biodiversity and natural ecosystems. Finally, ongoing loss of traditional cultures and breakdown of traditional resource management systems - such as diverse agroforestry systems, improved fallows, and traditional fishing practices- further exacerbate the loss of biodiversity and ES. In addition, as traditional, diverse agricultural systems are replaced by intensively-managed monocultures or export crops, the accompanying local and indigenous knowledge about agro-ecosystems and their biodiversity is also lost, thereby foreclosing the opportunity to incorporate this knowledge into the future development of SEM practices.

In most parts of Latin America, a combination of these factors is at play, with the BAU scenario, therefore, one of ongoing ecosystem degradation and biodiversity loss. To move away from this model, it will be important to address both the underlying and proximate drivers, and reduce the pressures on natural ecosystems and biodiversity.

3.8 ROLE OF PUBLIC SECTOR AND MARKETS IN ECOSYSTEM MANAGEMENT

This section is an overview of the role of the public and private sectors in maintaining biodiversity and ES.

Public Sector Role

Governments can play three roles to influence how sectors consider and manage ES:

- 1) Public expenditure invested into biodiversity and ecosystem management;
- 2) Policies that incentivize certain sustainable or unsustainable practices including “perverse incentives” like subsidies for deforestation and cattle ranching, or for agrochemical use;
- 3) Regulations that set standards for practices and internalize externalities

The Economic Commission for Latin America and the Caribbean (ECLAC) commissioned a series of studies to analyze the evolution of expenditures in seven countries of the region on environmental protection, following a standardized approach. In most countries (Argentina, Brazil, Mexico, and Trinidad and Tobago), environmental spending has not increased since the late 1990s, and, in some, it has decreased. Only in Colombia, Costa Rica, and Chile has the trend been positive. Even in these cases, the percentage of GDP dedicated to environmental protection is small: 0.64% of GDP for Costa Rica and as low as 0.04% for Trinidad and Tobago. These numbers are even more striking if put in the light of per capita contributions.

Costa Rica dedicates \$31/person/year to environmental protection, whereas Colombia dedicates about \$2/person/year (Table 3.1). Further, there is a lack of studies in the region on the effectiveness of these budget expenditures and their impact on maintaining biodiversity and ES. While increasing public spending on conservation of biodiversity and ES is needed, equally important is to examine current spending and remove perverse incentives that drive actions damaging to biodiversity and ecosystems (such as land conversion from forest to livestock, from mangrove to shrimp production, or from pantanal to soya).

Table 3.1. National Environmental Expenditure as % of GDP Country

ARGENTINA	0.18	14	1999
BRAZIL	0.4-1.4	N/A	1993-2000
CHILE	0.48	20	2000
COLOMBIA	0.11	2.19	2001
COSTA RICA	0.64	31.41	2000
MEXICO	0.26	16.53	2000
TRINIDAD & TOBAGO	0.04	3	2000

A second area of government influence concerns policy incentives and regulation, both command and control and market-based instruments. Well designed policies should aim at creating incentives for private agents to behave in society's best interest. These incentives will include factors that trigger private inventiveness in finding cost-saving strategies to comply with regulation, such as individual transferrable quotas (ITQ), territorial use rights in fisheries (TURF), and co-management of PAs.

Although financing environmental protection and the adoption of environmental policies remains heavily dependent on public resources and initiative, the involvement of the private sector in the support of ES and biodiversity conservation is essential. Furthermore, it is the private sector's initiative that can successfully bring innovation and product differentiation in favor of environmentally-friendly goods.

Market and Private Sector Role

The *private sector* has remained limited in undertaking direct actions to manage ecosystems and, in many cases across sectors, continues to degrade them, mainly due to sound economic reasoning. First, enterprises value short-term profits (e.g., annual stockholder returns) in detriment of long-term planning. This is compounded by the fact that long-term investments in certain natural assets have been perceived as risky due to weak property rights and non-exclusivity of

public access resources. Enterprises have had the option to abandon highly deteriorated ecosystems and move to fresh resources where available. Secondly, many firms have not had to pay for the supply of ES on which they are in part dependant. For example, from bottling companies to agriculture to hydropower plants that purchase water, the commodity of water is purchased at a price that allows for conservation of the water provisioning service.

Exogenous factors also affect the firm's decision-making process. To date, there is a limited amount of demand for green products within the LAC countries and access to niche markets in developed countries is hindered by rules of access and lack of standardized national policies. This is changing at an accelerated pace, but governments should provide a leveled playing field in terms of national rules and policies for all firms interested in exporting in pursuit of higher prices and stable demand.

Businesses respond to incentives. Sometimes these incentives come from changes in consumer preferences. Often, changes in the playing field push enterprises toward more environmentally-sustainable practices. The firm's incentives are shaped by public policies, which include rules and regulations, but also market-based incentives and the provision of information to shape consumer demand. Consumers increasingly demand taking care of the natural resources that enter or are used as inputs for their consumption basket. What previously were regarded as contributions to a public good (reduced pesticide use or bird friendly production), are slowly coming to be considered a positive characteristic of a private good that can lead to a higher market price.

This section reviews some of the ongoing efforts taking place in the region to promote SEM and some of the policies that encourage them.

Agriculture: There is evidence that consumers are prepared to pay more to support growers in developing countries and/or to protect the global environment. Organic, Fair Trade, Shade Grown, and other eco-certification labeling programs can command a price premium or improve market volume and are, therefore, mechanisms through which ES benefits can be captured and SEM promoted. Potential price premiums for certified products need to be balanced against potential production cost increases or yield decreases that may (or may not) result from more SEM production practices. Certification has already provided benefits to producers across the region including banana producers in Peru, Mexico, and Ecuador; coffee producers in Brazil, Columbia, Costa Rica, and Guatemala; and cocoa producers in Mexico.

Forestry: The Reduction of Emissions from Degradation and Deforestation plus (REDD+) scheme gives a new opportunity to forest dwellers and PAs to receive revenues from standing forests that can continue to provide carbon benefits if maintained. For Ecuador, the potential yearly income is estimated at \$36 million, for Brazil \$208

million, Venezuela \$35 million, and Bolivia, Peru, and Mexico just under \$20 million (Huberman et al. 2008).

LAC region has also 17 sub-national REDD-plus current projects in an advanced stage of implementation. Most are in South America: Brazil (7), Ecuador (1), Paraguay (1), Peru (4), and Bolivia (1). Guatemala also has three projects well advanced. Together, these projects aim to protect around 14.8 million ha of tropical forest, avoiding emission of about 522.7 million tons of CO₂ (equal to over half of the total annual emissions from the transport sector in the European Union (Cenamo et al. 2009).

Fisheries: When fishers' future access to fisheries resources is insecure, there are strong incentives to maximize profits in the short-term, often leading to overfishing, development of overcapacity, and a race to fish. Catch shares, territorial use rights, and related management systems are designed to provide individuals or groups with greater security over access to the resource in the future (for example, by granting rights to a share of the total allowable catch). These systems create incentives to maximize fisheries revenues over a longer time-frame by investing in maintaining or restoring fish stocks, and improving economic efficiency. The LAC region is probably home to a wider variety of catch share systems than anywhere else in the world, with examples in Argentina, Chile, Mexico, and Peru, among others. Implementation of these approaches often requires legislative change but early results from the region include increased catches and improved economic performance.



The Peruvian anchoveta fishery is the largest single species fishery in the world (Hatzios and de Haan 2006), but has long been characterized by extreme variability and occasional collapse (Fréon et al. 2008). To address this, fisheries managers had set the total allowable catch each year at levels designed to allow a fixed biomass of fish to escape the fishery. In addition, fishing is banned during the two main reproductive seasons and when a high percentage of juveniles are found in the catch. Industrial fishing is also banned within five miles of the coast to protect anchoveta spawning and the habitat of other commercially valuable species. Together, these measures have served to avoid resource depletion in recent years and reduce the risk of collapse, and thus already represent substantially progress toward SEM. However, catch limits have also stimulated an economically inefficient race to fish and led to massive fishing overcapacity.

In 2009, individual catch shares were introduced to address these issues. Without reducing total landings, catch shares have effectively eliminated the race to fish, increased the length of the fishing sea-

son, reduced the percentage of juveniles in the catch, and improved the quality of fish landed. This example demonstrates how improvements in economic performance can be based on responsible fisheries management that serves to safeguard fisheries resources and broader ecosystems.

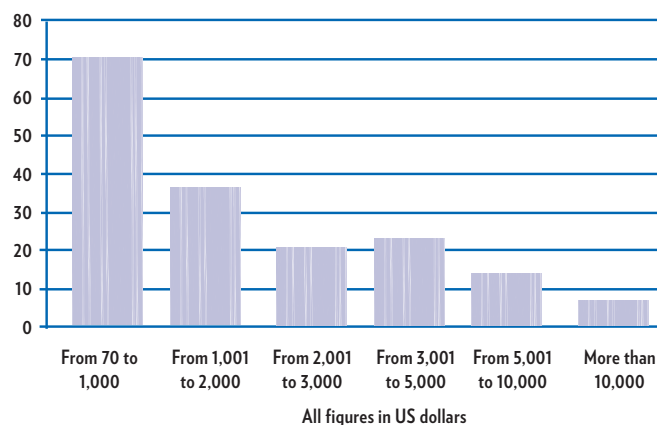
Tourism: Nature-based tourism is the fastest growing segment in the industry. Tourists in that category spend more per capita than conventional tourists; their spending also has a greater multiplier effect in local economies. Growth of this segment is threatened by unsustainable environmental practices. As natural capital continues to be eroded by conventional mass tourism, segments of key markets, investors, and the media are increasingly seeking alternative sustainable tourism options. Demand for such products is currently high in key European and North American markets. This demand will provide significant business development opportunities throughout the LAC region. Certification of tour operations has played a small role to date, but demand is growing and is likely to become increasingly important in signaling “green” status to visitors planning their trips.

Protected Areas: PAs can raise productivity in agriculture, fisheries, forestry, hydropower, and nature-based tourism, among other sectors. Both terrestrial and marine PAs provide restricted-take zones where biodiversity can rebuild and species heavily fished or hunted can recuperate and re-stock neighboring areas. Economic benefits derived from PAs include jobs, local and national income, and they function as drivers of foreign exchange earnings and investment, through related tourism. The benefits of PAs are not equally distributed; sustainably managed PAs can contribute to equity and poverty alleviation; women, rural communities, and indigenous peoples are afforded opportunities that help build empowerment. A number of countries have moved toward SEM practices with better financing of their PA systems in pursuit of such benefits (e.g., Costa Rica, Mexico, and some Brazilian states).

Hydrologic Services: LAC has a long history of donor- and government-led investments in watershed protection and management. In the last decade or so, the region has made a major contribution to environmental policy through experimentation and innovation with payment for watershed service schemes, which now come in many shapes and sizes, spanning the continuum from private to public initiatives. Costa Rica and Mexico have developed large, national level schemes financed by revenues from the energy and water sectors. Quito, Ecuador has piloted an innovative municipal Water Fund concept in which water users contribute financially to management

The focus of CAMBio on SMMEs has so far led to approval to fund 192 initiatives that conserve biodiversity and, at the same time, are economically and socially viable, successful activities.

Figure 3.2. CAMBio Credits by Size



of the watersheds from which their drinking water comes. Many other countries in the region are developing these schemes, including many local, community-based schemes to protect water quality. These schemes remain limited in their coverage, but are generating some \$5 million/year in funds for protection activities. Further, the rapid rate with which they are being replicated and upscaled suggest not only that they can be a major force for SEM, but reveal that re-investment in watersheds by water users is increasingly a mainstream idea in the region.

New Investment Funds for Green Business

There are numerous Funds established supporting sustainable agriculture and forestry in LAC. These include Root Capital, Verde Ventures, Futuro Forestales, EcoEnterprise Fund, and CAMBio.

Verde Ventures, managed by CI, has invested \$15 million in 79 loans to biodiversity-based enterprises, across 13 countries, with a repayment rate of 92%. Most of the loans have been for sustainable coffee and cocoa.

CAMBio, an investment program supported by UNDP and GEF, works with the Central American region financial sector network, namely the Central American Bank for Economic Integration (CABEI), its execution agency, and members of its extensive network of financial intermediaries (FIs). Over the last three years CAMBio has developed new financial products that are generating substantially increased lending to biodiversity-friendly small, micro, and medium enterprises (SMMEs) for investments that create biodiversity benefits on productive landscapes within the Mesoamerican Biological Corridor. The FIs include banks and non-banking financial institutions of the region's five countries. The focus of CAMBio on SMMEs has so far led to approval to fund 192 initiatives that conserve biodiversity and, at the same time, are economically and socially viable, successful activities. These funded initiatives include silvopastoral systems, coffee agroforestry, cocoa agroforestry, sustainable tourism, and organic agriculture productive sectors. The payback has been 100%. Figure 3.2 shows the distribution of the project by size categories, showing investment opportunities at all scales of enterprise.

The EcoEnterprise Fund was launched in 2000 as a joint initiative of TNC and IDB. It was a 10-year closed-end fund that invested in small-scale and community-based environmentally and socially responsible businesses involved in sectors that complement Sustainable Ecosystem Management (SEM) efforts: sustainable agriculture (including organic agriculture, apiculture, and aquaculture), NTFPs, sustainable forestry, and ecotourism (Box 3.6). Over the ten-year period, EcoEnterprises Fund deployed \$6.3 million in risk capital in 23 small and growing businesses in 10 countries in Latin America. Success of the Fund is measured against a "triple bottom line" of financial, environmental, and social returns. Collectively, these investments generated impressive results. They created 2,000 jobs; benefitted 289 communities and conservation groups; generated \$290 million in sales; leveraged \$152 million in additional capital; and conserved over 1.3 million acres of land. All the businesses financed practice SEM approaches and are proving worthy investments. Financially, the Fund performed in line with, or better than, most investment funds, even traditional venture capital funds investing in conventional sectors. Twenty businesses from its portfolio of 23 firms are still in business, an enviable statistic for any venture fund.

Box 3.6. Investment examples from the EcoEnterprise Fund

An EcoLodge Company in Peru: A Community's Equity Stake in Ecotourism

One of the Fund's investments in ecotourism is a company that operates three high-end lodges in the Peruvian Amazon. The company not only protects unique biodiversity near its lodges, specifically through the preservation of macaw clay licks, but also has created an incredible partnership with the local indigenous community. One lodge is co-owned with the community, which receives 60% of the lodge's net income. Over \$1.1 million has been paid to the community, and \$1.3 million in other economic benefits have accrued to the community since the lodges' inception.

continued in the next column

Garden Furniture from Bolivia: From the Certified Forest to Your Backyard

To help protect Bolivian forests, the Fund invested in a company manufacturing Forest Stewardship Council (FSC)-certified garden furniture and other consumer wood products. The company's plant in La Paz includes a 330,000 square foot manufacturing facility with close to 600 employees, making it one of the largest wood products plants in the country. Forests managed under FSC principles must address community rights, protect biological diversity, and preserve the functioning of forest ES through selective logging and other sustainable practices. The company holds an FSC Chain-of-Custody certificate, and the company's major suppliers have FSC Forest Management certification. The company has worked closely with local indigenous communities to help promote certification efforts.

Organic Dehydrated Fruit in Ecuador: Value-added Products from an Abundant Fruit Supply

The Fund invested in one of the first companies in Ecuador to commercialize organic dried tropical fruit, including bananas, mangoes, and papayas, for local and export markets. In 2009, the company decided to develop an organic gooseberry line, the first in the country, and sought technical assistance from the EcoEnterprises Fund to help identify and develop a certified supplier base. The company continues to expand its product offerings and now, in addition to its original strategy of marketing organic dried fruits, has developed finished fruit mixes for retail, as well. The company is now replicating its business plan in Mexico.

Organic shrimp: From Ecuador to the World

Another of the Fund's investments in an industry first-mover was an Ecuadorian company dedicated to the production and sale of certified organic shrimp. In a country where the shrimp industry has been responsible for much environmental degradation, decimating coastal mangrove habitat, the company is committed to building a sustainable model for aquaculture. The company shifted from conventional shrimp farming methods that rely on chemical inputs to Effective Microorganism (EM) technology, an approach developed in Japan that employs a mixture of anaerobic organisms to feed on waste, helping to maintain water quality. The organic techniques helped produce shrimp resistant to diseases, enabling the company to survive blights that affected neighboring farms. In order to position itself in the US and European markets, the company has pursued organic certification through various certifying agencies, most recently the Soil Association. As part of its certification efforts, the company has restored over 90 hectares of mangrove forests around its farms; annual monitoring has confirmed the return of various birds and fish species to the area.

Markets for Biodiversity-based Products¹¹

An additional source of revenue in SEM forestry and agriculture is the marketing of native and/or rare species through sustainable harvesting. This relies on communities' local knowledge and the restoration of threatened species and ecosystems. Restoring and maintaining ecosystem integrity is often necessary for communities to earn a living. The example in Box 3.7 is typical.

Box 3.7. Golden Grass Handicrafts

Capim dourado (*Syngonanthus nitens*) grows in the humid grasslands of the Cerrado biome in Brazil. Handicrafts are made from these extraordinarily golden, bright flower stems and sewn together with buriti (*Mauritia flexuosa*) palm silk. The most common handicrafts are hats, baskets, boxes, bracelets, and earrings. The sustainable management and harvesting of capim dourado for unique handicrafts helps to prevent the conversion of the Cerrado from its natural state. But it wasn't always this way. While many communities make capim dourado handicrafts today, it all started with a community of slave descendants, Mumbuca. A woman from Mumbuca learned how to use capim dourado for crafts from nearby indigenous people. Since the time of its inception, capim dourado handicrafts were very popular. Their popularity led to over-exploitation. Today, in cooperation with scientists, local communities have contributed in formulating a specific legislation that establishes the period and management procedures for the capim dourado harvest. This law guarantees that the harvest of the flowers stems takes place only after the maturation of the seeds, and that they are left in the field in order to help maintain specie populations.

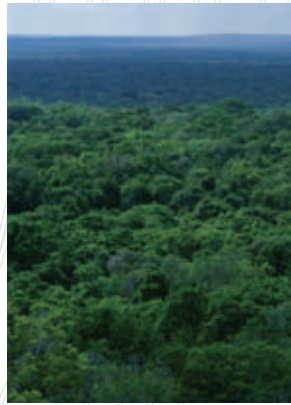
According to documented research, the sustainable harvesting of capim dourado law is maintaining the population of capim dourado at ecologically healthy levels (Schmidt 2007). The research also concludes that as far as NTFPs go, capim dourado is a shining example for income generation. Artisans earn \$65-\$350/month. This is 1.5 times the minimum salary in Brazil at 2004 levels. This is in an area of Brazil where the majority of the population does not have formal employment, especially women. Capim dourado handicrafts benefit women immensely by providing an income where they otherwise would have none. Lastly, the short life cycle of capim dourado allows for additional economic activities throughout the year.

¹¹ "Biodiversity Products in Latin America and the Caribbean: Economic Gains Count towards Conservation," Corrina Steward, Biodiversity Consultant, UNDP/GEF Small Grants Programme.

Further examples of products found and sold in LAC are shown in Table 3.2

TABLE 3.2. A SAMPLE OF NON-TIMBER FOREST PRODUCTS FROM LAC

AGRICULTURAL PRODUCTS	FOOD PRODUCTS	MARINE PRODUCTS	TIMBER PRODUCTS	ARTISANAL HANDICRAFTS	HEALTH & BODY PRODUCTS
NATIVE PLANTS AND ANIMAL PRODUCTS	JAMS AND JELLIES	Oysters, Costa Rica	Native Tree Nursery, Costa Rica	Capim Dourado (Golden Grass) Handicrafts, Brazil	MEDICINAL PLANTS
Quinoa and Kiwicha Flours, Argentina	Oca Jam, Argentina	Mangrove Clams, Costa Rica	Certified Wood and Forest Products from a Community Forest, Mexico	Cattail Crafts, Costa Rica	Cats Claw, Costa Rica
Andean Cornmeal, Argentina	Yacon Jelly, Argentina	Cultured Marine Bath Sponge, Cuba		Yuchan Masks, Argentina	Partners of Nature Medicinal Plants, Costa Rica
Andean Potatoes, Argentina	Uvilla and Chigualcan Jam, Ecuador	Dried Seamoss, Trinidad		Sheep Wool Garments with Natural Dyes, Argentina	Yacon Tea Infusion, Argentina
Dehydrated Suillus luteus Mushrooms, Bolivia	Sumak-Delicia Andina Marmalades made from Andean Tubers, Ecuador	Shrimp from the Natural Lagoons of Fonseca Gulf, Nicaragua		Recycled Glass Jewelry and Key Chains for Sea Turtle Preservation, St. Kitts	Essence of the Aromatic Jamaica
Oca (Oxalis tuberosa) Flour, Bolivia	Elderberry Jam, Peru	Black Conch, Nicaragua	Pine Seeds, Nicaragua	Tabla Cordón Handicrafts, Bolivia	Pepper Plant, Nicaragua
La Granacha Organic Swiss Cheese, Nicaragua	Aguaymanto Jam, Peru	Mangrove Conch, Ecuador			Medicinal Tea infusions, Panama
Guinea Pig, Peru	Tomatillo Jam, Peru	Gualajo (White Snook) and Sea Bass (Yellowfin Snook), Ecuador		Satchels made from Bromelia hieronymi, Bolivia	BATH AND HAIR PRODUCTS
FRUITS AND NUTS	DRINKS AND JUICES	Wild King Prawn (Whiteleg Shrimp), Ecuador		Amazonian Tree Resin Incense, Bolivia	Pacari Gueroba Body Lotion, Brazil
Palqui, Bolivia	Coquinho Azedo Pulp (Sour Coconut)	Fresh Chilean Blue Mussel, Chile		Chonta Palm Handicrafts, Bolivia	Macaúba Soap, Brazil
Baru Toasted Nut, Brazil	Frozen Pulp, Brazil	Artisanally Harvested Lobster, Mexico		Educational Wooden Toys, Nicaragua	Partners of Nature Shampoo, Costa Rica
Dehydrated Cerrado Cashew, Brazil	Carambola Juice, Costa Rica			Recycled Paper with Natural Dyes, Ecuador	Jatropha Soap, Cuba
Pequi, Brazil	La Reserve Organic Hot Cocoa, Dominican Republic			Water Bottle made from Tree Gourd, Ecuador	Aloe Vera Shampoo, Bolivia
Araza, Costa Rica	Bio Mididi Palm Fruit Juices, Bolivia			Traditional Kichua Wooden Handicrafts, Ecuador	Organic Honey Shampoo, Nicaragua
Organic Bananas, Costa Rica	Algarrobo Pod Syrup Drink, Ecuador			Purse made from Amazon Ornamental Plant (Shiguango Muyu), Ecuador	Ikiam Alma Amazónica Personal Care Products, Ecuador
Masica, Honduras	Dried Fruits for Tea, Preserves, and Jams, Chile			Naturally Dyed Fabrics, Chile	Organic Honey Products, Mexico
Sustainably Grown Cashews, Nicaragua	HONEY			Kuxtal Sian Ka'an Artisanal Wood Products, Mexico	Herbal Soaps, Panama
Carob, Peru	Natmel—Natural Honey from Native Bees, Brazil			Peruvian Native Cotton Crafts Woven by Hand, Peru	
CACAO	Honey Bee Curubande, Costa Rica			Handcrafted Reed Dolls, Peru	
Native Thin White Cacao, Nicaragua	Organic Honey, Cuba			Jipi Japa Handicraft, Peru	
Aromatic Organic Cacao, Ecuador	Native Bolivian Honey, Bolivia			Artesanía de Yarey (Giant Wax Palm), Cuba	
Raw Chocolate, Costa Rica	Dry Forest Flower Honey, Ecuador			Hat, Baskets, and Brooms made from Copernicia baileyana (Bailey Palm), Cuba	
COFFEES	Native Ecuadorian Honey, Ecuador			Tagua Nut Sculptures, Panama	
Biolley Hill Organic Coffee, Costa Rica	Dry Forest Organic Honey, Peru			Coco Bolo Wood Sculptures, Panama	
Café La Amistad, Costa Rica	Honey from Melipona Bees, Mexico			Chunga Baskets Handicrafts, Panama	
Café Rio Platano, Honduras	Rainforest Honey, Belize			Intercultural Educational Toys, Panama	
La Granacha Organic Coffee, Nicaragua	COOKING OILS, VINEGARS, AND SYRUPS			Traditional Cotton Kuna Indian Hammocks, Panama	
Organic Coffee, Nicaragua	Banana Vinegar, Costa Rica				
Certified Organic Arabica Coffee, Ecuador	Yacon Pickling Brine, Argentina				
Blue Mountain Coffee, Jamaica	Yacon Syrup, Argentina				
INSECTS					
Butterfly Pupae, Costa Rica					
NATURAL FERTILIZER					
Organic Fertilizer, Nicaragua					



PART II

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 4. CONCLUSIONS

Andrew Bovarnick¹²

The Report has provided an analytical framework and a set of examples, by sector, to identify where and how ecosystem services (ES) act as valuable economic inputs to major sectors in Latin America and the Caribbean (LAC).

Until now, LAC economic growth has been largely dependent on the use of renewable natural resources. The economic benefits of such a development path have been substantial, as reflected in the continued GDP growth of the region and the economic role that natural resource sectors have played in national economies. However, the Report has identified various costs of ES degradation resulting from Business as Usual (BAU) production systems, as well as various benefits from ES maintenance by alternative Sustainable Ecosystem Management (SEM) production systems. The value of ES for different sectors is detected by comparing those costs and benefits and is an important factor for consideration in mainstream decision making on economic development.

The data collected and presented are by no means comprehensive and definitive. However, there have been sufficient numbers of studies in the last two decades that assess the costs and benefits of different production systems in LAC; this body of information is such that this Report is able to form a set of conclusions around the following themes:

1. Role of ES in sectors
2. Costs of BAU practices
3. Benefits of SEM practices
4. Role of policy on ES value
5. Transition from BAU to SEM

On balance, emerging studies and an increasing body of knowledge work, together, to refine understanding of the relationships between ES, sectoral output, and economic growth; this improved

understanding is critical to informed policy making. This situation represents progress over earlier black and white statements postulating either that conservation of ES is a barrier to economic development or — the other extreme — that ES have infinite value and any degradation of these services is uneconomic. This Report helps to highlight the middle ground: the trade-offs and the ability to see both the costs and benefits of ES management.

For many LAC countries to remain competitive in coming decades, the conclusions of this Report chapter should be incorporated into policy making. The final chapter, which presents recommendations, builds on the key messages here.

Key messages are:

1. ES should be viewed as inputs into sectoral outputs. The values of ES are relative to other inputs and are influenced by market, policy, and institutional factors. Overall, there is sufficient ecological and economic evidence to suggest a strong contribution of ES to economic growth and equity in LAC.

2. The economics and drivers of sectoral outputs are changing. These changes are increasing both the economic costs of ES degradation and the benefits of ES maintenance. Evidence suggests that the relative value of maintaining (and not degrading) ES is increasing.

3. Countries should concern themselves with the rising and hidden costs of BAU from certain sectoral production systems. If the transition from BAU to SEM does not take place soon, there is considerable risk that BAU will cause long-term damage that will undercut future economic growth. This is especially true for ecosystems close to

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their ecological thresholds, which, once crossed, can lead to heavy costs and even sectoral crashes. Early action is better than delayed action so as to avoid ecosystem failures and the irreversible loss of dependent economic activity.

4. Analytical capacity is needed to compare BAU and SEM scenarios fully, to capture ES value, and to determine optimal approaches. There are win-win situations in which economic benefits accrue both for transitioning out of BAU and for moving into SEM. These win-win situations result from a mix of avoided costs, maintained output, and access to new market opportunities. In other cases, there are short-term costs associated with the BAU to SEM transition that need to be financed or otherwise mitigated to hasten realization of long-run gains. There are also trade-offs: in certain circumstances, continuing BAU and accepting ES depletion makes economic sense. These cases will, generally, be site specific and will depend on a variety of factors.

5. Costs and benefits of ES degradation should be viewed at the sectoral and multi-sectoral levels. ES values are higher when aggregated across the variety of production systems to which they have inputs, than when they are assessed on a site-by-site basis.

6. In the past, maintaining ES was viewed as a barrier to economic growth. Evidence suggests that conditions are changing and ES conservation is important to sustain growth, provide access to emerging green markets, avoid damage costs, provide resilience to climate change, increase efficiency in the use of scarce resources, and reduce production costs. The renewable natural resource base is a key capital asset of rural households and enterprises; low-income families rely on ES even more in times of economic stress.

7. Countries can increase the economic benefits of ES and SEM practices through specific policy changes and by supporting selected production and supply chains in transition to SEM (sector-wide change all at once is not needed).

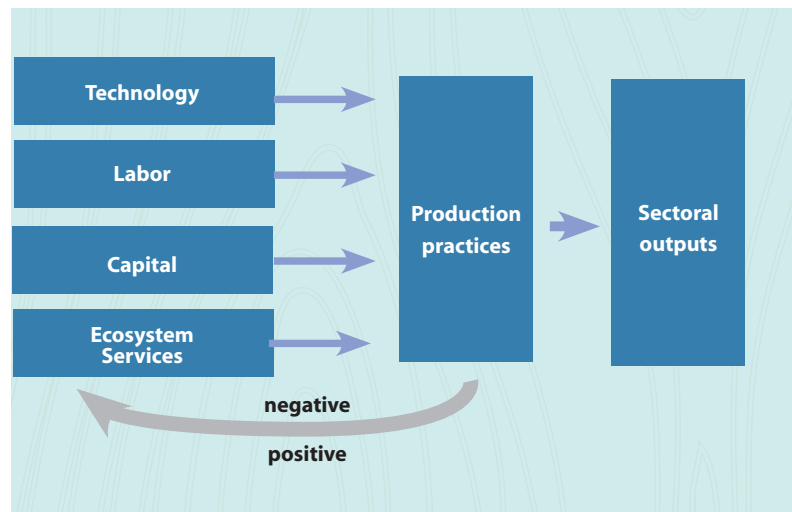
8. SEM practices are advantageous to low-income rural communities that depend more on ES because they have limited access to substitutes (technology, capital) or alternative income sources, should their ES-based production fail. The poor tend to be more exposed and vulnerable to externalized BAU costs like air and water pollution, and can less afford medical care.

These conclusions and messages are based on site- and context-specific examples. They should be considered a foundation for exploration within each country, and tailored to the specific factors and conditions faced by each sector in each country.

4.1 ROLE OF ECOSYSTEM SERVICES IN SECTORS

ES should be viewed as inputs to sectoral outputs along with labor, capital, and technology, as suggested in Figure 4.1.

Figure 4.1. Production Practices: Inputs and Feedback Loops



Many natural resource-related sectoral outputs require ES as inputs, as per Box 4.1. Additional examples are found in each of the sector chapters in this Report.

Box 4.1. Examples of Dependence of Sectoral Outputs on ES Inputs

- Timber and non timber forest product production in both natural forests and plantations are dependent on soil fertility, soil moisture, microclimate, photosynthesis and growth using CO₂ and releasing O₂, biodiversity and gene pools, pollination and seed distribution, soil stabilization, and forest water cycles.
- Productivity in agriculture depends in fundamental ways on the management and maintenance of certain ES: water availability, soil fertility, microclimate, pollination, and both pest and disease control. Agriculture uses 70% of all water abstracted in LAC. Furthermore, ES will build resilience of the sector to climate change, by protecting genetic resources, soil fertility, and water quality.

- In tourism, the most valuable ES for the sector are water quantity and quality, beach material, attractive viewscapes, and biodiversity for recreation like bird and whale watching, or jungle treks.

- Fisheries are dependent on provisioning and regulating ES. The most direct input of marine ES to fisheries is by providing fish habitats essential to the life stages of fish species, including the food chains to supply energy. Of particular concern to fisheries is the loss or degradation of habitats crucial for spawning and/or recruitment, such as mangroves, seagrass beds, and coral reefs. Regulating and supporting services ES (such as sediment retention, temperature control, water filtration, and nutrient-cycling) are essential to fisheries but difficult to value directly. The inputs of regulating and supporting ES are inseparable from the value of the provisioning services that also depend on them.

In the past, these ES were more abundant and could be degraded without noticeable effect on sectoral outputs, because they could be replaced or substituted. The sector chapters show that some ES are substitutable with technological inputs (e.g., soil fertility can decline but be regained by fertilizer use). Fisheries are a sector where ES are not easily substitutable. Even aquaculture depends on wild capture fisheries for feed.

Examples of costly technological input-substitutes for ES are: water quality degradation requires increased water treatment infrastructure and sediment removal machinery; soil fertility degradation requires inputs of fertilizer and other products; reduced natural pest control requires increased pesticide, crop variation, and management effort; reduced natural habitat for pollinator species requires artificial propagation and transport of honeybees or other pollinators; and reduced natural habitat and biodiversity require alternative attractions for tourism.

The overall cost to a sector of degrading an ES to a sector depends on capacity for substitution by other inputs and the costs of this substitution. The costs of technological fixes will change over time as ES degrade and require more inputs. There are limits on the extent to which human-made inputs can substitute natural ES; some services cannot be fully replaced. As ES degrade the cost of substitution tends to rise. Once an ES stops completely, no amount of substitute may work, effectively terminating the economic activity reliant on this loss service (e.g., high temperatures or sediment loads kill coral reefs).

4.2 COSTS OF BAU PRACTICES RESULTING IN ECOSYSTEM SERVICES DEGRADATION

The main types of costs that sectors and countries face from ES degradation under BAU production practices include:

- **Reduced productivity from ES decline:** As ES degrade and substitution becomes more difficult (e.g., soil fertility and use of fertilizers) BAU costs will increase.

- **Off-site downstream costs:** Some BAU impacts have no financial costs to the business producing them because these costs are externalized (e.g., runoff of agrochemicals into drinking water reservoirs). This means that there is limited direct incentive for firms to reduce such costs and transition to SEM practices.

- **Lost public sector revenues:** Large BAU costs can translate into small financial costs for the enterprise, due to subsidies and to a lack of regulations (and enforcement) preventing externalities; these conditions typically mean low rates of public sector cost recovery (fees) and lower taxation.

- **Future increase in costs:** Small BAU costs now that grow over time, will make transitioning to SEM more costly in the future (such as sedimentation of dams from forest clearance). This situation includes potential BAU costs experienced from an irreversible collapse of an ES and associated products.

It is evident that certain resource use-patterns, while currently still generating net economic benefits, over time may be reduced in economic efficiency and end up costing more than the alternative investment and operational practices that would have maintained the desired ES inputs.

There are cases where one sector impacts ES that affect a different sector and degrades other essential ES (such as topsoil retention, nutrient cycling, water filtration, and freshwater flow regimes) or destroys them altogether (fish reproduction habitat may be destroyed by activities originating outside capture fisheries, such as clearing of mangroves). Sectoral dependence on ES that, in turn, are impacted by other sectors shows the need for inter-sectoral collaboration and cooperation on ES management.

The cost of ES degradation is often unseen at a sectoral level because each sector is supported by a variety of ES; these ES are often considered separately for different products and supply chains and not taken in an aggregate manner. For example, agriculture relies on several ES: water supply, soil fertility, pest control, and

pollination. Each ES on its own often warrants more attention from Ministries of Agriculture, but when taken together, aggregated, and bundled the economic benefits of these ES become even more apparent and powerful. Vice versa, activities that affect many ES, such as overuse of pesticides, should have their impact assessed cumulatively across all relevant ES, because the costs on a single ES may not make a good business case for ending the BAU activity.

The costs of ES degradation from BAU production practices vary, depending on:

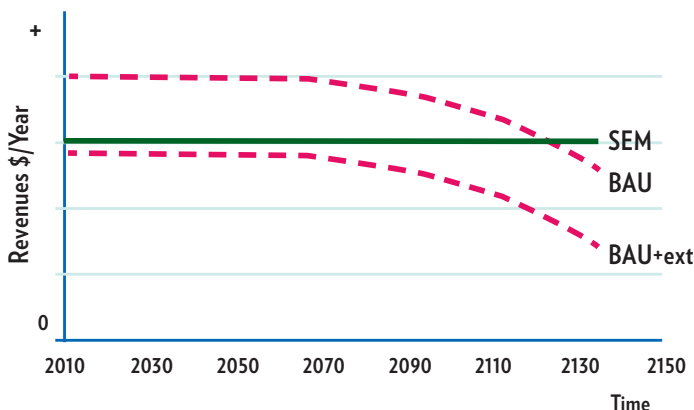
- The causal relationship between ES and specific sectoral production,
- Level of existing ES degradation and scarcity,
- Strength of negative feedback loop of sectoral impact on ES experienced in specific production chains,
- Surrounding land management activities,
- Substitution effects with other inputs (technology, labor), and
- Policy incentives / regulation / fees / penalties.

Reduced Productivity from Ecosystem Services Degradation

BAU practices in the agricultural sector are leading to declines in productivity. The cost of substitutes will increase as these ES deteriorate, raising food costs. Similar costs are observed from local scarcity of irrigation water, microclimate features, pollinators, pest-eating bats, and others.

Gradual degradation of BAU returns: This degradation often takes place slowly, over a long period. Under this scenario, BAU is financially superior to SEM in the short run but not in the long run. This situation is represented conceptually by the green line in Figure 4.2. Continued ES degradation adds cost to BAU so that over time this approach becomes less profitable. Taking into account hidden costs and subsidies (red line) shortens the time for SEM to become the superior approach. (Note: this graph and several of the following visual are based on the discussion in Chapter 2.3.)

Figure 4.2. BAU-SEM Standard Paradigm



Sectoral examples: In agriculture, decreasing soil fertility under BAU raises fertilizer costs to farmers. Studies in Central America

and the Caribbean show that, while rates of degradation vary across crops and sites, in all cases, returns on production gradually decline without conservation measures. Off-site costs of soil erosion, such as siltation of dams and canals, further reduce the economic viability of BAU practices. These off-site costs, typically, remain external to private decisions without policy initiatives to ensure that these off-site costs are accounted for in assessing operating costs. SEM, by comparison, maintains soil fertility and lowers fertilizer costs over time.

BAU in fisheries threatens or causes economic loss through overfishing, damage to essential habitat, and degradation of ES. The same yields could be captured with less effort, thereby freeing up capital and other resources. Depletion and fisheries collapse, which occur regularly under BAU, can incur high costs in lost yields and greater travel expenses to fish offshore after depleting inshore resources.

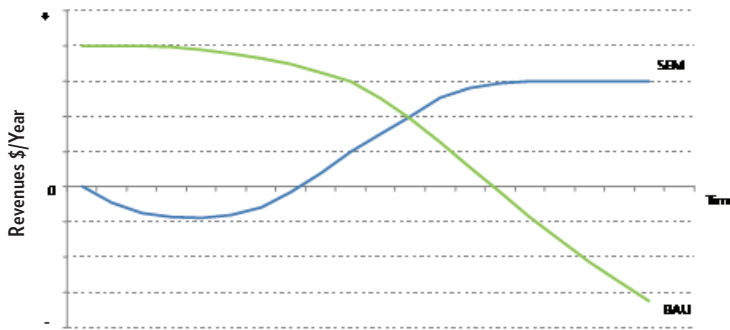
Some subsidies, such as tax exemption on fuel or access to low-interest credit for fleet development, create perverse incentives that directly contribute to overfishing and development of overcapacity (Seijo 2009).

In forestry, net gains from BAU practices — timber and deforested land available for agriculture — decline as accessible, easy-to-work forests become scarce, thereby raising costs. Growing societal resistance to predatory logging practices and to externalization of impacts brings regulation and fees, further raising costs. As the curve for BAU net returns is forced downward, scarcity of forest resources and the development of more sophisticated market opportunities (e.g., certification, PES) raises the returns possible via SEM.

In some cases, BAU production systems continue for a time despite low or, in extreme cases, negative net revenues. This may be explained by a cultural attachment to the practice, the practical difficulties of leaving a business due to high sunk costs, or vested interest in resisting the switch to SEM, with its regulations, taxes, and internalized costs. A shift to SEM may, however, have immediate positive economic benefits on a societal level. (See Section 4.5 for further discussion.)

Start-up costs for SEM: In many cases, SEM practices will improve long-term returns, but there are barriers to switching. These barriers are discussed in detail in Section 4.5, “Transition from BAU to SEM.” As represented in Figure 4.3, net revenues under BAU decline as shown in the previous graph, but the net revenues of SEM decline at first, due to the initial costs, then rise, once the start-up period has finished.

Figure 4.3. Start-up Costs for SEM

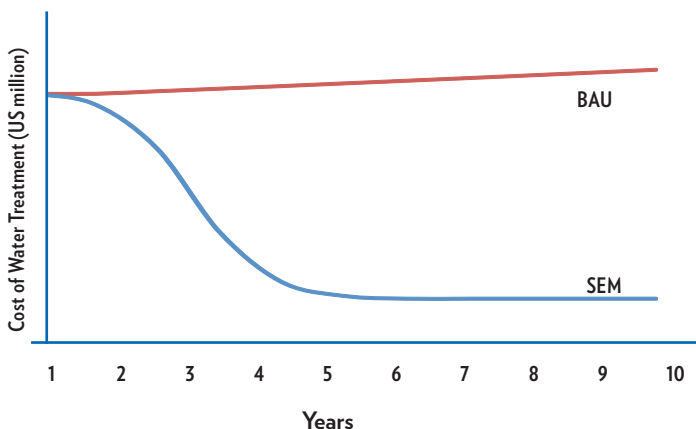


Sectoral examples: Silvopastoral systems have high start-up costs but, over time, provide better returns. Under BAU, in comparison, revenues start to decrease from the start, due to the undercutting of the ES on which productivity is based (e.g. soil fertility). Policies that support the initial investment costs (technical assistance, credit) would hasten the uptake of silvopastoral systems. Similar situations arise in fisheries, forestry, and tourism production chains that require up-front investment to adopt SEM practices, and where returns take time to develop.

Off-site Downstream Costs

Off-site downstream costs are often associated with degradation of water services to agriculture, human settlement, tourism, fisheries, and hydropower. An example of water service degradation is the case of water supply from the Chingaza National Park in Colombia, where the Bogota Water and Aqueduct Company (EAAB) will benefit from investing in watershed protection (SEM). A four-year conservation investment will pay off by saving part of the \$4.5 million annual cost for sedimentation removal incurred under the previous BAU administration. Without SEM, costs of sediment removal would continue to escalate. Figure 4.4 illustrates the BAU and SEM scenarios over time as an externalized cost is internalized (SEM).

Figure 4.4 Costs of Sediment Removal under BAU and SEM, Bogota Water Supply



See the Report chapters on Protected Areas and Hydrological Services for further examples on maintenance of ES linked to water quality. Downstream costs in fisheries include the destruction of coral reefs by agricultural run-off (both sediment and pesticides carried out by river mouths to down-coast reefs), as well as destruction of mangrove estuaries (marine species nursery sites) by tourist resorts.

Loss of Public Revenues

State revenues can be affected by activities that degrade ES by (i) low revenues from low prices for ES use and (ii) expenditure in subsidies for ES degradation.

In BAU forestry, low public revenues from forestry-related taxes and fees perpetuate BAU practices. In countries where the state has ownership or control of forests, it is generally private interests rather than the public sector that benefit from revenues raised from forest resource extraction. Low returns for governments from taxes, fees, and concession charges are common in LAC. This situation undercuts public finance and support for transitioning to SEM, and also reinforces the pattern of treating forest resources as free goods, sending the wrong market signal and encouraging continued BAU practices.

In BAU fisheries, both harmful subsidies and overcapacity serve to distort production incentives. Addressing these issues should be integral to any incentives-based approach to fisheries management. Many fisheries in LAC are heavily subsidized (Khan et al. 2006). Some subsidies, such as tax exemption on fuel or access to low-interest credit for fleet development, create perverse incentives that directly contribute to overfishing and development of overcapacity (Seijo 2009). Reducing such perverse subsidies is an essential step to re-aligning private incentives with national economic interests. While subsidy reduction is often unpopular, opposition can be mitigated by reorienting subsidies toward investment in responsible fisheries management, including efforts to reduce illegal and unreported fishing, especially by foreign fleets.

In BAU protected areas, prices charged to international visitors in Bolivia and Peru were far below the levels that they were willing to pay for the use of the national parks visited. At the same time, lack of investment in visitor facilities and management was leading to degradation of the resource.

Future Costs

There are certain practices that generate short- and medium-term income but over the longer term are not financially attractive. This is particularly visible in forestry and tourism. For example, BAU forestry clear-cutting practices lead to diminishing returns for companies and farmers, and, hence, have long-term costs. Within deforested humid tropical lands, agriculture, ranching, and forest plantations that follow BAU practices in the long run are marginally

profitable, if at all. This is especially true where accessible, easily-worked bottomlands are deforested first, and more costly clearing of marginal, steeply-sloped areas continues. Sharply declining fertility undermines future agricultural or forest productivity. This decline, ultimately, affects not only farmer income, but because of land conversion, also the livelihoods of forest-dependent peoples who experience loss of vital NTFP. Fertility loss in the aftermath of deforestation brings increasing use of fertilizers to compensate, raising production costs and, in the process, the polluting of ground and surface waters.

Benefits of SEM Practices Resulting from Maintained Ecosystem Services

The sectoral analysis has identified many SEM practices that can be financially viable, particularly with changing markets. The main benefits are:

- Direct financial benefits from increased productivity and lower costs,
- Diversified revenue streams,
- Payment schemes including carbon revenues,
- Employment benefits,
- Equity benefits,
- Reduced risk and avoided damage costs from natural disasters, and
- New green market opportunities.

Common SEM practices include watershed management, agroforestry and silvopastoral production methods, low-impact forest concessions, nature-based income diversification, nature-focused sustainable tourism, and organic farming. Some of the policies that promote sustainable land use include zoning, certification, payment for ecosystem services, improved access to green markets, support to SEM businesses during start-up, and shifting subsidies from yield optimization to SEM.

Direct Financial Benefits from Management Practices

SEM forestry practices can lead to reduced costs and higher profitability for private firms. Examples of SEM practices, such as mixed species plantations and reduced impact logging (RIL), were found to offer better financial returns for companies. Despite the overall benefits of RIL prescriptions, the lack of information on the real costs of conventional logging and other BAU practices impedes wider adoption of SEM approaches.

SEM agriculture, in many circumstances, can be more profitable than BAU. For example, 90% of 21 agroforestry systems studied in Central America resulted in higher returns, compared to traditional cultivation (a Net Present Value of \$2,863/ha over 10 years compared to \$1,423/ha obtained from contour planting under BAU and \$764/ha from woodlots; [Current et al. 1995]), and better soil management practices in Southern Brazil resulted in higher

incomes for farmers (total farm income rose by \$98,460/yr for maize; \$56,071 for soybean; \$12,272 for beans; and \$10,730 for tobacco [Bassi 2002]). Businesses practicing SEM can reduce their operational costs (e.g., fertilizer, pesticides, equipment, labor) while society gains from the reduction in external costs. Producers are also generally less at risk with low-input systems in the event of rising prices or scarcity of agrochemicals. Evidence from Costa Rica suggests that organic coffee plantations and those incorporating leguminous tree species can better sustain productivity levels in the event of decreasing fertilizer use.

Under SEM, the rebuilding of fish stocks, reduction of fisheries capacity to levels that match the productivity of the resource, reorientation of subsidies, and elimination of the race to fish all serve to increase returns on investment over the long run. In the long-term, SEM fisheries will also reduce fishing effort, increase catch per unit effort, and improve the economic efficiency of fisheries. Maintaining stock biomass is also likely to promote greater stability with respect to both biomass and yields (Worm et al. 2009).

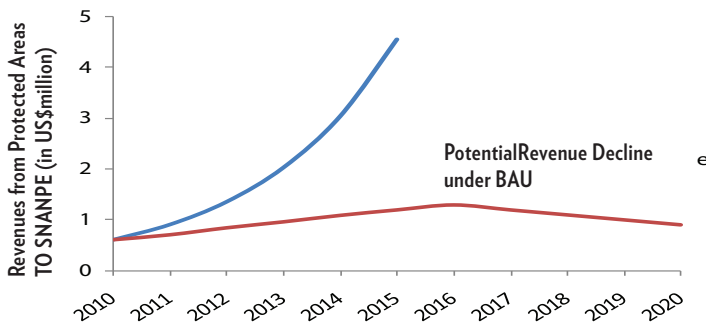
For fisheries affected by severe depletion, moving toward SEM will involve a temporary reduction in yields, but successful rebuilding will lead to greater yields over the long term. The case study of Peruvian anchoveta indicates that improved returns on investment that may be realized by eliminating the race to fish. In this example, the mechanism involved, a reduction in fixed costs by reducing overcapacity (estimated at 60% to 80%) in both the harvest sector and the processing sector, plays out in two ways: directly, in the case of the harvesting component and indirectly, for the processors. The dynamics of the latter are reflected in a sharp increase in the price for anchoveta offered to independent vessel owners, implying a reduction in profits for independent processors that should lead to a lower processing capacity.

A meta-analysis of fully protected marine reserves and large-scale fisheries closures showed a four-fold average increase in catch-per-unit effort in fished areas surrounding them (Worm et al. 2006). Burke and Maidens (2004) looked at productivity differentials between fisheries located on healthy and degraded reefs. Based on a literature review, it was estimated that healthy reefs in the Caribbean would support a maximum sustained yield of 4 tons of fish/km²/year. Yields from degraded reefs were estimated at between 0.7 and 2.9 t/km²/year. Based on these assumptions, maximum sustained yields for 26,000 km² of Caribbean reef were estimated at 100,000 t of fish/year. At market prices of \$6/kg on average, gross fisheries revenue was estimated at \$625 million/year if all reefs were healthy, declining to \$190 million-\$280 million under BAU by 2015. Net revenues may be only 50% of gross revenues, after accounting for the costs of vessels, fuel, gear, etc. The study. Therefore, estimated the potential annual net benefits from healthy reefs at \$310 million.

Nature-based tourism businesses have been flourishing and bring visitors to PAs, particularly in the Caribbean, and to Costa Rica,

Guatemala, Panama Peru, Ecuador, and Bolivia. While some PAs maximize visitation to increase revenues, degradation of PA assets risks a decrease in visitor enjoyment and reduced visitor flow in the future. Under SEM, PAs sustain assets and. Hence, future visitor and revenue streams. Important economic benefits come from nature-based tourism in PAs. For instance, PAs in Peru generated an estimated \$146 million of tourism-related economic activity in 2005 (CBD 2008). Studies show that introduction of SEM practices in PAs can boost current PA tourism-based revenues. For example, four national parks in Peru, currently under BAU practices, generate some \$600,000/year. If there is no shift to SEM, revenue may reach as much as \$1.2 million, with a high potential to decline due to wear and tear. However, with a shift to SEM, revenue could increase to \$4.3 million/year in five years (León 2010). This is illustrated in Figure 4.5.

Figure 4.5. Potential Growth of Tourism Revenue from PAs under BAU and SEM in Peru



Diversification of Revenue Streams

Because ES offer many benefits, there is potential for many sources of revenue from maintaining ES within productive landscapes. This is different from BAU, which has sole focus on yield optimization, over the short run.

Forested protected areas under SEM management provide opportunities to generate income both for private enterprise private and for the public sector from concessions, fees and taxes, and payment of environmental services (water and carbon). Concessions for controlled harvesting of timber or NTFP or for attending tourism, user fees and taxes on enterprise earnings, and income flows from PES for watershed protection, carbon sequestration, and other ES: these instruments could make state-owned forests and forested protected areas self-sustaining revenue centers. The concession schemes for sustainable timber production in Brazil's national forests (FLONAS) are a good example.

Funds from public sector revenue-sharing programs can be converted to payment schemes for ES maintenance. Brazil has been a pioneer in these payment mechanisms to reward local governments for adopting SEM practices. The use of environmental criteria for

tax redistribution among municipalities is a particularly well-established and successful scheme. The Green ICMS (“ICMS Verde”) system is created to compensate municipalities that have protected areas within their territories for the resulting revenue loss, as well as to develop new mechanisms of environmental management, to encourage creation of new protected areas to conserve biodiversity, and to reward municipalities for the ES they provide. In Parana, this tool has generated about \$170 million toward conservation over 14 years and has more than doubled the number of protected areas. In the first three years of application in Minas Gerais, this tool generated about \$17 million, benefiting protected areas in 217 municipalities. Parana has started a mechanism to transfer some of the Green ICMS revenues directly to private reserve owners. In 2005, seven landowners received \$85,000.¹³

In agriculture, Pérez (2004) found that Brazilian households with greater agricultural diversity had higher and less variable agricultural incomes, suggesting that incomes become more stable at higher levels of agricultural diversity. For example, silvopastoral systems reduce dependency on chemical fertilizers and pesticides, save water for irrigation, protect soils and enhance fertility, and provide potential for additional incomes from harvesting fruit, fuelwood, and timber.

Payment Schemes for Sem Practices

There are an increasing number of public and private payment schemes for environmental services (PES) in the region. For example, Brazil's Bolsa Floresta program provides financial compensation to indigenous people for conserving the Amazon forest. Bolsa Floresta began (shift to SEM) in 2008 with 4,244 families registered, of which 2,702 were eligible to receive “Bolsa Floresta Familiar” subsidies of \$22 to female-headed households who reside in conservation units and commit to actions related to watershed protection.

REDD+: Reduction in Emissions from Degradation and Deforestation (REDD-plus) may be included in the post-Kyoto regime to reduce greenhouse gas emissions, increasing the options for land owners to receive revenue for PES from standing forests. Under REDD+, developed countries would pay developing countries to lower deforestation rates by implementing a range of policies and projects. By linking these payments to carbon markets (putting a value on the carbon emissions that are avoided), investments could cut deforestation in developing countries in half by 2030, lowering emissions by 1.5-2.7 Gt CO₂/year (Huberman et al. 2008). Voluntary REDD markets also offer significant potential (see Forestry chapter).

A 10% reduction in annual deforestation rates from this scheme would generate more than \$600 million annually with carbon

¹³ Adapted from Young (2005) and TNC (2009).

priced at \$5/t (Eliasch 2008). For Ecuador, the potential yearly income is estimated at \$36 million, for Brazil \$208 million, Venezuela \$35 million, and Bolivia, Peru, and Mexico just under \$20 million each (Huberman et al. 2008). However, regulations for this market are not yet defined, so this potential system is yet to be realized and actual future revenues remain uncertain. Actual amounts invested will depend on details of the final agreement.

Employment Benefits

Labor markets are complex and it is difficult to generalize about direct causal links between ES degradation and employment. However, three patterns have been observed in the research used in the Report.

1. Agricultural SEM activities tend to be labor intensive and, thus, create jobs, particularly in rural areas that are usually in need of employment opportunities to avoid rural exodus. Smallholder farming practices tend to be more labor intensive than extensive monoculture. Agroforestry, organic farming, and “living” fences tend to have higher labor requirements than traditional approaches.

2. Restructuring fisheries from BAU to SEM may require an initial reduction in employment, given that overcapacity (including labor capacity) is a major aspect of inefficiency in the sector. In the long run, SEM sustains employment as fishery stocks are generally higher, to maximize economic yields, and less likely to crash. Addressing cases of chronic overfishing may lead to an increase in employment, sometimes within relatively short time frames. In Peru, the introduction of catch shares led to an increase in length of the first fishing season in 2009 to 102 days from 33 days in 2008.

3. Protected area-related tourism generates employment around protected areas. Venezuela’s Morrocoy National Park receives some 1.5 million visitors annually. It is estimated that 5,000 permanent jobs have been created in areas adjacent to the national park, half the employment in the area (Cartaya and Pabón Zamora 2009). Similarly, the other most visited protected areas in the country provide 30%-50% of local jobs.

Equity Benefits

By maintaining ES that low-income households often rely on, SEM also is an approach that shares economic benefit across socio-economic groups within a landscape.

This is particularly the case for community forestry. SEM forestry approaches include many options for forest-based communities, from timber and wood products to NTFP, PES, and ecotourism, among others. The case studies presented in earlier chapters de-

scribe local initiatives such as the Maya Nut Program, showing that by recovering traditional knowledge of native species use and through exploring new markets, local NGOs can conserve ES while improving income and food security in rural communities. Likewise, the concession model with Forest Stewardship Council (FSC) certification in the Maya Biosphere Reserve case, supported by international NGOs and development agencies, has also proved useful for conserving natural forests that provide economic benefits to rural communities.

Agriculture can also help reduce poverty if smallholders, individually or cooperatively, become suppliers to modern food markets, good jobs are created in agriculture and agro-industry, fair trade policies are pursued, and payments for environmental services are introduced. Since small farmers are, typically, more directly exposed to environmental degradation, they are positioned to be beneficiaries of SEM. SEM practices reduce household vulnerability to shocks, both economic and environmental. During extreme events, low-income households with minimal savings rely heavily on local natural resources; these households will tend to be more stable in SEM. SEM tends to be more labor intensive than BAU. In the BAU agricultural frontier, employment gains are limited because of extensive mechanization and cattle ranching. SEM practices can reverse this.

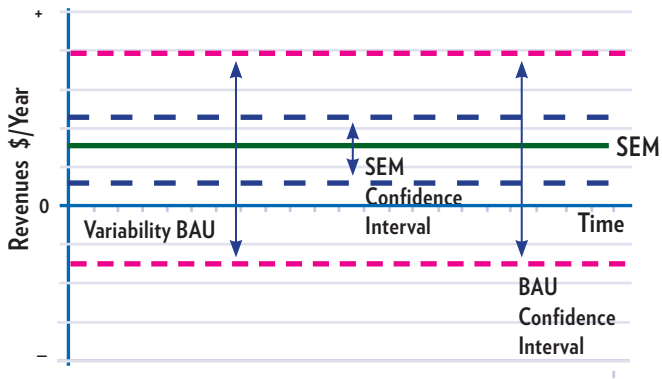
PES schemes, a tool of SEM, can have redistributive aspects as they reward financially land managers in forested and upper catchment areas who are often smallholders and communities.

Protected areas under SEM can have more sustainable and equitable natural resource management, particularly for indigenous populations, when local communities are empowered to participate in patrolling, tourism, and NTFP extraction. Protected areas contribute to the wellbeing of local populations by providing opportunities for jobs and seasonal income, particularly in nature-based tourism and NTFP collection and processing (e.g., natural rubber in Brazil, and Brazil nut in Bolivia and Brazil).

Reducing Risk From Natural Disasters

Reducing risk from natural disasters lowers infrequent but major damage costs, particularly from flooding and other storm damage. Many conserved natural habitats and SEM production systems act as buffers: forests, coastal vegetation, coral reefs, agroforestry and silvopastoral systems, protected areas, and sustainably-managed watersheds among these buffers. Climate change introduces additional risk and uncertainty into the economic projections of many sectors. Production systems with reduced ES will be more vulnerable to climate change shocks and, hence, the potential impact under BAU will be greater. Figure 4.6 shows a lower level of variability and, thus, uncertainty under SEM than under BAU.

Figure 4.6. Vulnerability to Climate Change under BAU and SEM: Uncertainty as a Factor



Sectoral examples: Agriculture, with its dependence on rainfall and temperature is highly vulnerable to climate change and variability. The implicit risk is reduced through the adoption of measures that include maintenance of crop and farming system diversity, use of drought-tolerant varieties, water harvesting and conservation, extensive planting, mixed cropping, agroforestry, low-input weed and pest control, and wild product gathering (diversification of income flows).

For example, farmers in Honduras consider a major benefit of the organic composting technique known as Quesungual to offer greater resilience to floods (crops under the system showed no major damage after hurricane Mitch). This sort of system can be critical to lowering risks and costs, particularly for Central America, given that, in the past decade severe storm and flooding events have hit almost yearly. For example in 2010, Tropical Storm Agatha destroyed agricultural lands with damage estimated at \$19 million in Guatemala, and Hurricane Mitch in 1998 wiped out an estimated 70% of crops in Honduras.

In addition to SEM practices within agriculture and forestry, well-managed protected areas are also important in disaster mitigation and prevention. Protected areas and well-managed forestry ecosystems retard run-off, slow flooding, reduce landslides, mitigate climate change, and help contain pest outbreaks. These services are very important to the more vulnerable sectors of the rural population, who live and work on lands exposed to such risks.

In fisheries, the use under SEM of Maximum Economic Yield (MEY) rather than Maximum Sustainable Yield (MSY) raises the standing biomass of the stock above the biological threshold of MSY, increasing stability and reducing uncertainty, and thereby distancing the risk of a crash.

Emerging Green Market Opportunities

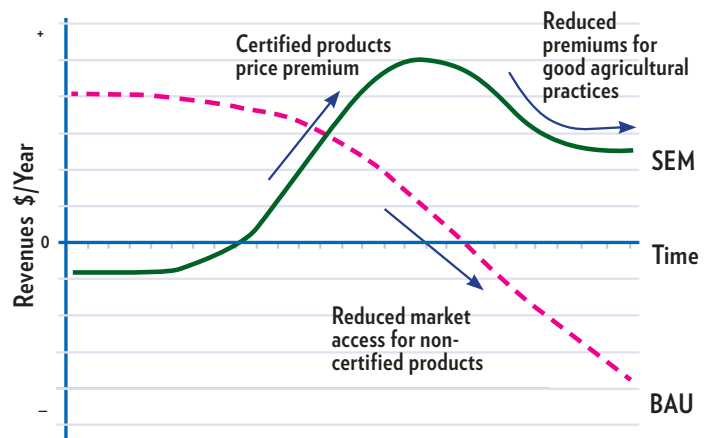
A common and strong trend across the sectoral reviews is a growing market opportunity for ES-based businesses. In addition to new

payments for biodiversity and ES, such as the carbon market potentially expanded by REDD+, there is growing consumer demand for products certified to be sustainably produced by organizations like the Forest and the Marine Stewardship Councils (FSC and MSC), the RainForest Alliance, the Center for Responsible Tourism, and many others. There is also a growing number of financing vehicles in the form of private investment funds that seek to finance biodiversity-friendly enterprise, providing much needed capital for commercialization and expansion of SEM business models.

Increased Demand for Certified Products

Changes in consumer preferences and other market forces can change the relative profitability of BAU and SEM practices. There is noticeable increased demand across forestry, fisheries, tourism, and agriculture for certified products. Certification often permits producers to receive premium prices for SEM products. Where price premiums are not realized, certification, at the least, is increasing access to competitive markets; indeed, non-certified goods risk losing access to traditional markets. This is represented in Figure 4.7, where the SEM line peaks with price premiums, then falls off somewhat but remains far superior to the BAU line, with its reduced market access.

Figure 4.7. Market Forces: Effects of Certification



Sectoral examples: Certification is being expanded throughout LAC where producers are responding to the growing markets for organic and environmentally-certified products. For example, organic coffee in Mexico, Brazil, Nicaragua, Dominican Republic, Guatemala, and Costa Rica; beef certification in Brazil; and banana certification in Peru, Ghana, Mexico, and Ecuador: the changes have improved market access and farmer income, as has hotel certification in Central America.

1. *Forestry:* FSC timber certification is connecting a growing number of LAC forestry enterprises to large and growing markets in the EU and USA, where consumer support for certified products is more developed. In certain market niches, certification may also permit access

to premium prices for forest products. Certified forests are now a very small share of total forested area, around 1.2%, but growing rapidly. A significant emerging opportunity for companies and communities that exploit forest products is to differentiate their products, and making these entities more competitive through certification.

2. Agriculture: Markets for certified agricultural products are growing in LAC. For example, farmers have been able to raise their profits by producing organic coffee in Mexico, Brazil, Nicaragua, the Dominican Republic, and Guatemala. Beef certification in Brazil has improved access to international markets.

3. Fisheries: Certification schemes can provide incentives for SEM fisheries by granting privileged access to high-value markets and enabling product differentiation, based on commitment to responsible fisheries management and reduced ecosystem impact. Some large retailers are only purchasing certified fish (e.g., Walmart); non-certification can lead to market exclusion. Two fisheries in LAC have been certified by the Marine Stewardship Council (MSC): the Patagonia Scallop (Argentina) and the Baja California red rock lobster (Mexico). Fisheries currently being assessed for MSC certification include the Sian Ka'an and Banco Chinchorro Biosphere Reserves spiny lobster (Mexico), the Gulf of California sardine (Mexico), and the Suriname Atlantic seabob shrimp.

New Investment Funds for SEM Business

Various funds have been established to support sustainable agriculture and forestry in LAC. These funds include Root Capital, Verde Ventures, EcoEnterprise Fund, Futuro Forestales, and CAMBio (see Section 3.8). The focus of CAMBio (a UNDP/GEF credit program with CABEL) on SMMEs has, thus far, led to approval of 192 initiatives that comply with the requirements of conserving biodiversity and of pursuing economically and socially viable, successful activities. The funded initiatives include silvopastoral systems, coffee agroforestry, cocoa agroforestry, sustainable tourism, and organic agriculture projects. The payback rate has been 100%.

Verde Ventures, managed by Conservation International, has invested \$15 million in 79 loans to biodiversity-based enterprises across 13 countries, with a repayment rate of 92%. The majority of loans have been for sustainable coffee and cocoa.

Over a decade, TNC's EcoEnterprises Fund deployed \$6.3 million in risk capital in 23 small and growing businesses in 10 LAC countries. The Fund's performance is measured against a triple bottom line of financial, environmental, and social returns. Collectively,

the investments achieved impressive results, creating 2,000 jobs, benefitting 289 communities and conservation groups, generating \$290 million in sales, leveraging \$152 million in additional capital, and conserving over 0.5 million ha of land.

These investment portfolios demonstrate that attractive economic returns are possible from well-run SEM based businesses across tourism, agriculture, forestry, and fisheries.

Markets for Biodiversity-based Products¹⁴

An additional source of revenue in SEM forestry and agriculture is the marketing of native and/or rare species through sustainable harvesting. This example relies on local knowledge within communities and the restoration of threatened species and ecosystems. Restoring and maintaining ecosystem integrity often improves options for communities to earn a living.

One example is the capim dourado (golden grass, *Syngonanthus nitens*), a golden and bright flower stem that grows in the humid grasslands of the Cerrado biome in Brazil. Handicrafts are made from this product, sewn with buriti palm silk. The most common products are hats, baskets, boxes, bracelets, and earrings. Artisans earn \$65-\$350/month, at salary levels about 1.5 times the minimum in Brazil (2004). Capim dourado handicrafts benefit women immensely by providing an income where they otherwise would have none. Sustainable management and harvesting of capim dourado for the handicraft industry helps to prevent the conversion of the Cerrado from its natural state; the communities work to keep the ecosystem intact for production of the capim dourado.

A fuller range of products found and sold in LAC are shown in Table 3.2 (Chapter 3).



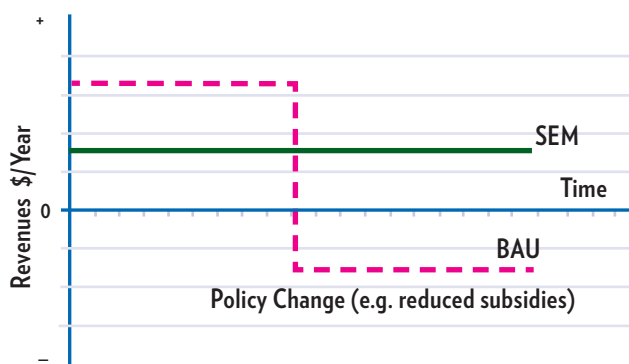
¹⁴ Biodiversity Products in Latin America and the Caribbean: Economic Gains Count towards Conservation," Corrina Steward, Biodiversity Consultant, UNDP/GEF Small Grants Programme.

4.4 ROLE OF POLICY ON ECOSYSTEM SERVICES VALUE

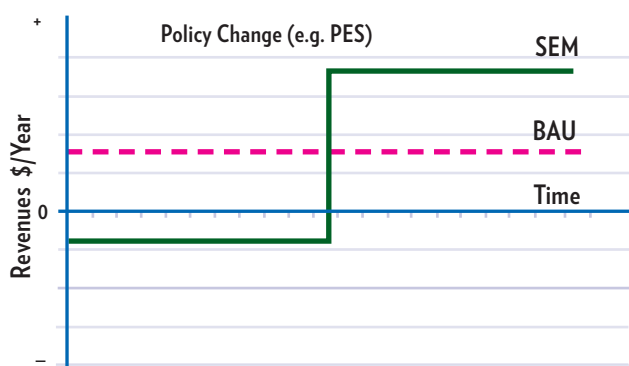
Within all these sectoral transitions from BAU to SEM to capture the value of ES, the link between policy and management practice is central. The policy environment can be a key driver in decisions for transition. Subsidies and removal of subsidies can have an important influence on the price of goods and services, as reflected in Figures 4.7a and 4.7b below. Removal of the possibility of externalizing or hiding costs produces a similar shift against BAU (Figure 4.8a) in favor of SEM (Figure 4.8b).

Figures 4.8a and 4.8b: Effects of Policy Change on Trade-off Between BAU and SEM

Policy Change: Discouraging BAU



Policy Change: Encouraging SEM



Sectoral examples: By removing subsidies on fertilizer and for BAU cattle ranching, SEM gains relative to BAU, while policies that support PES can reward landowners for maintaining otherwise un-priced ES. Pilot PES projects to restore degraded pastures to silvopastoral systems are underway in Columbia, Costa Rica, and Nicaragua. Subsidies to underwrite purchase of fishing vessels and fuel promote overcapitalization of fishery fleets and overfishing;

similarly, subsidized infrastructure construction (roads, water, sewage) has contributed to over-building, over-exploitation, and degradation of tourism sites.

Currently, most LAC policy frameworks support BAU activities; hence, they have an economic advantage and appear preferable to SEM practices. The profitability of agriculture under BAU is often supported by incentives, which if removed, would level the playing field for SEM. For example, unsustainable pasture expansion in the Amazon and elsewhere has been encouraged by government land titling policies and subsidies for livestock credit and road construction, among other perverse incentives. Widespread under-pricing of forested land, water, and fertilizer promotes their overuse. Incentives could also be put in place to support SEM, like tax breaks for certified products and PES. With proper incentives and other policies, agriculture's environmental footprint can be lightened and its ES harnessed to foster protection of watersheds and biodiversity.

Policy reform also needs to be changed across the enabling environment to improve institutional roles and property rights.

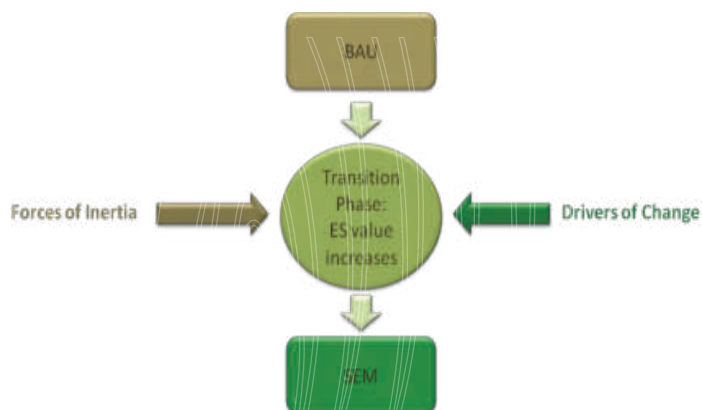
To realize the economic advantages of SEM, policy will often need to be changed. Policy regimes that favor SEM will then influence BAU enterprises to shift to SEM practices. Policy reform also needs to be changed across the enabling environment to improve institutional roles and property rights. Movement toward these changes can make the transition from BAU to SEM economically rational at the national level and affordable at the enterprise level.

4.5 Transition from BAU to SEM

The conclusions above indicate that the economic value of ES is relative and varies over time depending on geographic location, market conditions, policy framework, and the impact of alternate inputs – labor, technology, and capital. Over time, costs and benefits from specific production practices (BAU and SEM) change, leading to a phase of transition. It is the interplay of external factors – drivers of change – combined with the baseline conditions and forces of inertia that influence the relative economic value of ES and, hence, at what point SEM generates greater net benefits than BAU. The economic rationale for maintaining ES and, hence, for

governments and business to transition from BAU to SEM will vary depending on the underlying conditions. Figure 4.9 summarizes this process in which the relative economic value of ES changes and increases.

Figure 4.9. The Phase of Transition between BAU and SEM: the Role of Drivers of Change and Forces of Inertia



Source: A. Bovarnick

The examples provided throughout this Report show that there has already been progress in different sectors and countries in the transition from BAU to SEM. These transitions will likely become more frequent because each of the sectors has experienced changes to underlying conditions that are modifying the economics of ES in land management and production practices to make SEM more profitable and BAU less so.

The drivers of change to the relative value of ES include:

- Where once abundant, ES are increasingly scarce in most sectors and countries;
- Cost of inputs to substitute ES is increasing (e.g., labor, fuel, land, materials);
- Policy change affects BAU profitability and levels the playing field or gives incentives to SEM (externalization ended, energy or water subsidies reduced, tax breaks for certified products);
- Consumer preference change (in Europe and North America but also in LAC) favors SEM via price premiums for products that sustain ES. As certification grows in the marketplace, BAU competitiveness is reduced because there is less market access for non-certified product. Thus, the ability to capture ES value under SEM can generate business opportunity;
- Rural communities that in the past bore the brunt of BAU externalities (like contamination of water sources) are now becoming empowered through better governance across LAC, making their voices heard, and down-

stream costs more noticeable and unacceptable;

- Increasing knowledge of the value of ES and of cost-effective practices to maintain them;
- Climate change putting at risk sectoral output under BAU, while maintaining ES can increase resilience and facilitate adaptation to climate impacts; and
- The need to improve the competitive stance of enterprises and the sector vis-à-vis advances in production and marketing processes in other countries and regions.

Box 4.2 summarizes a situation in one sector in which a number of these drivers are acting to transform forest management practices to SEM across the region.

Box 4.2. An Example from the Forestry Sector on Drivers of Change

BAU forestry practices in LAC grew out of conditions of relative abundance of forest resources and scarcity of agricultural land. On the agricultural frontiers where countries were expanding their economies, forests were seen as an obstacle to economic growth, based on productive agricultural societies. Forest resources were treated as if they were cost-free inputs to the expansion of economic activities. Externalities fell not on the entrepreneurs using the forest resources, but on communities living in or close to the forests, or downstream. In this context, BAU approaches were successful: they fit the times. Later, as frontiers matured and the forest lands became scarcer, economic costs associated with deforestation have increased.

Timber-based enterprises have started to reconsider objectives and options for forestry management, including the greening of international timber and wood products markets that, increasingly, require certification. Meanwhile, there are growing markets for an expanding array of NTFPs. While usually not major economic drivers for large forest products companies, these markets do provide substantial local level benefits. SEM practices, such as mixed native species plantations, low impact selective logging, FSC certification, and sustainable NTFP extraction and processing, have begun to emerge as successors to BAU in the changing times.

Countering the *drivers of change* that build on the economic benefits of ES are the *forces of inertia*. These forces in the system tend to lower the economic value of ES and increase the cost of transition from BAU to SEM; hence, they favor maintenance of BAU practices. Costs of transition include those of adoption of new technologies (alternative energy sources), training in new methods

(conservation tillage or nature tourism guiding), new infrastructure (processing plants for certified products, with traceability), and new institutional arrangements (to manage PES). Resolving property rights and institutional reform is required in most countries to enable the monetization of ES and enhance the market opportunities for SEM to generate revenues. Tradition in production practices is also an important non-economic force of inertia that requires costly training to overcome.

Vested interests in maintaining BAU practices are another obstacle to transition. These can stem from distinct sources, from reluctance to cede long-standing economic advantages (like externalization of costs) to the value of sunk investments that would be lost. In many circumstances, significant investment has been made for BAU (e.g., water treatment facilities or large scale plantations). The loss of these sunk costs, combined with the cost of transition to SEM, may well not make economic sense, tipping the balance against transition, at least for the moment. Some countries have compensated owners of sunk capital (as in subsidizing the sale of excess fishing ships that contributed to over-capacity under BAU) to smooth the transition to SEM practices.

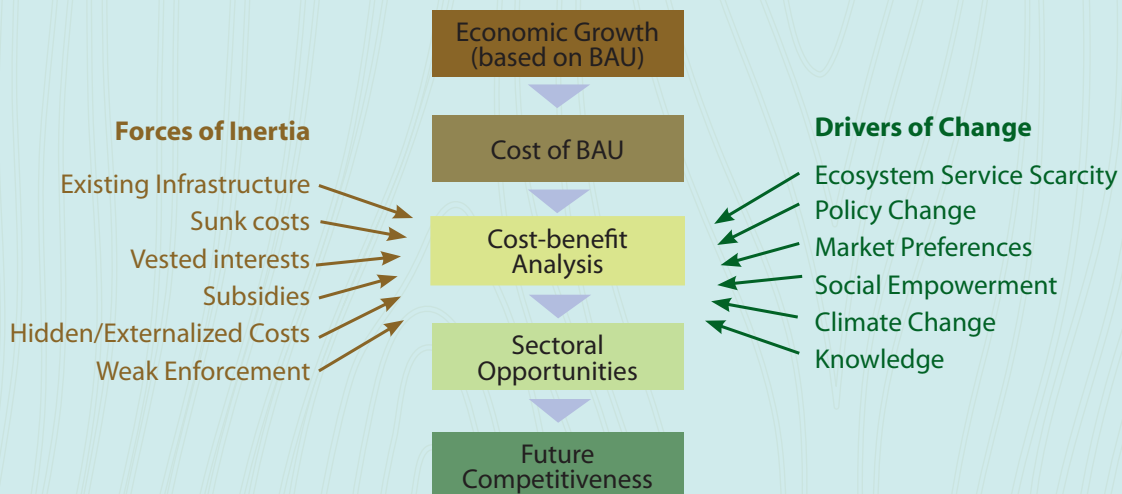
One of the biggest barriers to transition reported in the agriculture, forestry, and fisheries sectors is the difficulty faced by actors — individuals, communities, or firms — on having to forego their regular income from BAU practices, during extended periods, while waiting for the improved conditions under SEM to develop. Examples run from several months to several years required for soils to improve, trees to grow, or fish stocks to rebound. In such cases, where BAU production systems are reaching a point at where they are not profitable and the cost of transition makes economic sense, but BAU is maintained for lack of funds to cover the costs of transition to more appropriate technologies, arrangements for credit or PES

to bridge the gap have been recommended. The transition from BAU to SEM can also be influenced by policies in place beyond LAC. For example, subsidies in industrialized countries can hinder the export potential of LAC.

The interplay between baseline, drivers of change, and forces of inertia are represented in a diagram to represent the change being experienced by sectors in relation to ES value (Figure 4.10).

The foregoing conclusions in this chapter form the foundation for the recommendations that follow. These conclusions and recommendations should not be seen only as a final product of this Report but also as a starting point for further exploration and debate on the role of biodiversity and ecosystems in the economies of the region. It is hoped that this work will lead to the gathering of expanded, more widespread data, and, then, analysis in line with the methodology and analytical framework presented; this focus will lead to further refinement of the approach and of these conclusions, and to new application of the lessons emerging to assure sound management of the region’s natural capital and of the economic processes that depend on this capital.

Figure 4.10. Transition Rationale from BAU to SEM



Source: A. Bovarnick

CHAPTER 5.

RECOMMENDATIONS

Andrew Bovarnick¹⁵

This section provides a set of recommendations to countries in Latin America and the Caribbean (LAC) to assist in determining and perceiving opportunities and, then, to how capture value and benefit from the region's ecosystem services (ES), guided by government planning and market signals. These recommendations are anchored in the Report's conceptual framework that contrasts Business as Usual (BAU) and Sustainable Ecosystem Management (SEM) approaches, using this framework to analyze the array of evidence presented in the sector chapters, and in the findings and conclusions of Chapter 4.

The Report concluded that many countries in the region are experiencing drivers of change that alter the economic balance between BAU and SEM approaches and that elevate the relative economic value of ES in many sectors and sub-sectors. The primary drivers of change are

1. increased scarcity of ES, resulting from their degradation and depletion under BAU practices,
2. technological advances to increase efficiency of SEM practices,
3. climate change,
4. changes in consumer and market preferences for sustainable goods, and
5. improved knowledge of the costs and benefits of BAU and SEM.

The combined effect of these drivers strengthens the incentives for public and private sectors to transition from BAU to SEM.

To facilitate this transition from BAU to SEM, national governments, business, and other stakeholders should consider the follow-

ing recommendations that will help capture ES value in policy, planning, and investment actions to support sectoral and cross-sectoral economic decision making:

- 1) *Take into account trade-offs between maximizing short-term production and ES maintenance,*
- 2) *Level the playing field and/or provide positive incentives toward SEM,*
- 3) *Develop economic instruments and planning tools to reduce off-site degradation of ES,*
- 4) *Increase the asset value of biodiversity and ES perceived by business,*
- 5) *Augment public sector revenues from use of ES, and*
- 6) *Generate and capture of economic data on ES.*

Take into Account Trade-offs between Maximizing Short-term Production and Ecosystem Services Maintenance

The Report has shown that ES are an input into production across the economic sectors reviewed. A decline in ES levels can, in many cases, reduce production revenues and increase off-site costs. In some cases, the lost revenue will be marginal and may not be worth changing management practices to address this loss. In other cases, the losses can be substantial and likely to increase over time and, thus, merit consideration of remedies from an economic standpoint. In some cases, evolving societal values will argue for stewardship of ES even in the face of uncertain economic evidence.

Determining the economic value of ES for management practices is indeed complex and site specific. Findings from ES valuation stud-

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ies as presented in the Report have also revealed various hidden and unexpected costs associated with production maximization. Thus, it is important to look at the trade-offs associated with production and broaden investment planning to take them into account.

Sectoral plans should broaden from production maximization to a more balanced goal of economic efficiency in input use and long-term sustainability. Legislation should emphasize many priorities with clear guidance on trade-offs. The broad goals need to be translated into operational objectives, such as preventing resource depletion by setting extraction and pollution limits, and realigning market-based incentives to favor ES, given their long-term public benefits.

Another national planning tool for increasing emphasis on economic analysis is in the National Biodiversity Strategy and Action Plans for each country, as per the Convention on Biological Diversity. The Strategy and Action Plan can propose recommendations and reporting on transitioning to SEM. Strengthened economic analysis and coordination with sectoral plans will, in turn, strengthen the effectiveness of these Strategies and Plans.

Level the Playing Field and/or Provide Positive Incentives toward SEM

Governments should review policies to assure that their policy frameworks do not favor BAU needlessly, given the long-run, external or hidden costs of BAU. Propping up BAU activities in the face of the increasing attractiveness of SEM leads to unnecessary environmental degradation and can generate social conflict. Governments should also consider options that catalyze interest in SEM, both for enterprises based on the BAU model and for new start-ups deciding whether to follow the route of BAU or that of SEM. The main tools are

- Subsidy reform
- Tax breaks
- Regulations, specifically, to end externalization of costs, improve property rights, and reduce illegal activity

Subsidy reform: This tool would include removal of energy and water/irrigation subsidies, as well as other below-market pricing of inputs, including capital items. Governments should also consider incentives that foster moves toward SEM in the short-term because governments will benefit from this transition in the long run. A central approach for this is to switch current subsidies away from BAU production practices toward facilitating the transition to SEM practices. Options like subsidizing conditions to encourage organic farming or water-efficient technologies may be useful to speed change, but the options risk becoming another way of distorting market signals, if allowed to become permanent. An alternative is to introduce tax breaks for SEM practices that sunset after a defined transition period.

At a sectoral level, the following types of subsidies (direct and hidden) should be reviewed for their effects on long-term production by causing ES loss and negative feedback loops in the sectors:

- 1) Tourism subsidies include developing road infrastructure to undeveloped areas, which can generate interest in resort development but also can diminish the asset value of the biodiversity and ES within these undeveloped areas. Over-investment and over-capacity can result, bringing overuse and degradation of natural resources.
- 2) Subsidies for fishing vessels, equipment, and fuel generate excess capacity that leads to over-harvesting and declining fisheries stock, at the same time leading to lower rates of return for the fishing industry. These subsidies need to be reduced or neutralized, and funds devoted to support smart gear, fisheries research including studies to support ecosystem approaches to fisheries, monitoring and enforcement, capacity building, and management.
- 3) Agriculture subsidies for fuel, irrigation water, and agrochemicals influence ES, leading to excessive use of inputs and over-extraction of river and groundwater, which causes downstream dewatering and contamination of water bodies. Over-production of grain crops is also a result of such subsidies that further exacerbates the impacts of agricultural price support programs, putting downward pressure on crop prices.

Funds from these subsidy programs can be converted to payment schemes for ES maintenance. Brazil has been a pioneer in these payment mechanisms. This practice, recommended for wider consideration and adaptation, is described in the conclusions chapter.

Tax breaks: Tax breaks can be used in a variety of ways to provide positive incentives for SEM practices:

- Import and manufacture of SEM technologies (e.g., solar energy for hotels, agriculture, protected areas),
- Lending to SME enterprises, thereby reducing costs of loans from financial institutions, and
- Export of SEM products, increasing their international competitiveness.

Regulations to end externalization of costs, improve property rights, and reduce illegal activity: An essential feature of the transition from BAU to SEM is the emergence of a regulatory framework that limits the ability of BAU enterprises to ignore the external costs of their activities, in effect, dumping these externalities on other, typically marginal, groups. Then, these costs are often picked up by the public purse, in effect, subsidizing BAU practices. Effective monitoring and enforcement systems are indispensable; engaging stakeholders in their design and operation is often helpful.

National regulations should consider and support the following actions to capture ES value and to structure incentives so that sectors and marketplaces will appropriate their value:

- Improvement of property rights, and controlled resource use and access rights to better avoid BAU-style unilateral exploitation of common property resources. This action is particularly important for forests, fisheries, and water resources. Access control for fisheries through TURFS (territorial use rights) and ITQs (individual transferable quotas) plays a key role in generating incentives for sustainable management; similar mechanisms can be applied to water resources and non-timber forest products (NTFPs).

- Enforcement of SEM regulatory frameworks to reduce illegitimate activity that includes illegal extraction (logging, fishing), water pollution, over-use of protected areas, and mis-management of tourist sites. Efficient surveillance and control is critical to the success of incentive-based management in addition to SEM practices and traditional regulation.

Policies should be designed to avoid, minimize, mitigate, and/or penalize BAU producers for off-site or externalized degradation of ES that, in turn, reduce the profitability of downstream or other enterprises in the same or other sectors.

Develop Economic Instruments and Planning Tools to Reduce Off-site Degradation of Ecosystem Services

The Report has identified various ways in which sectors are negatively impacted by loss of ES. This loss is often a result of BAU activities within the sector but also can be a result of BAU practices by other sectors, often taking place upstream.

Where one sector's activity affects those of another sector, coordination between Ministries will be valuable. For example, when a Ministry of Tourism promotes a stretch of coast for development that will result in felling mangroves, that Ministry should undertake

studies and consult with the Ministry of Fisheries to assess the resulting cost to fishers. If development proceeds, then compensation schemes can be designed that capture the true costs; the budget for such compensation can be internalized into government decision making on the project budget.

Policies should be designed to avoid, minimize, mitigate, and/or penalize BAU producers for off-site or externalized degradation of ES that, in turn, reduce the profitability of downstream or other enterprises in the same or other sectors. Avoidance and minimization of impacts are promoted by leveling the playing field and providing positive incentives like those discussed above. Mitigation and penalties require implementation of the polluter pays principle. Mitigation funds and penalties should seek to recover economic damages, i.e., the economic costs entailed in the ES losses resulting from the BAU activity. These actions apply to these, and other, sectors: agriculture (e.g., agrochemical pollution of waterways), forestry (undue clear cutting), fisheries (fishing in ways that degrade a tourist attraction, like coral reef overfishing or breaking up whale shark aggregations), tourism (facilities damaging coastal resources valuable to fisheries, like mangroves; those damaging to tourism, like turtle watching spoiled by resort lights; or the building of unsightly hotels in a formerly lucrative viewscape).

One corollary action to these described tools is to use funds from mitigation and penalty programs to provide upstream maintenance of ES through payments for environmental services (PES) that provide incentives to landowners, managers, and communities to adopt SEM practices. Governments should continue to encourage and establish more and better PES programs:

- Calling for sustainable management of watersheds to avoid future infrastructure costs;
- Compensating for the maintenance of forests and biodiversity: PES for other ES, such as pollination and carbon storage, among others; and
- Assessing and improving the existing PES to ensure behavioral change and attainment of objectives.

Institutional capacity building and the sharing of experience and lessons across the region will be needed to support efforts in individual countries.

Increase the Asset Value of Biodiversity and Ecosystem Services Perceived by Businesses

The value of natural assets from the enterprise point of view needs to be raised by creating markets and developing economic instruments and technical assistance programs that support development of biodiversity and ES business opportunities. This action may be achieved by policies that support certification schemes to assist in capturing the economic value of certain ES (particularly biodiversity, habitat, water, and soil) and of practices that protect ES (re-

duction of pesticide use). Such policies should also include market demand stimulation and assistance for enterprises, particularly small and medium enterprises (SMEs), to overcome the initial costs to adopt SEM. It may be cost-effective to focus assistance on new start-ups whose costs to develop SEM models will be less than conventional businesses that already have sunk costs in BAU practices.

Government efforts to increase the asset value of ES for business can include:

- Scaling up demand for SEM products and supporting access to domestic and international markets for them;
- Fostering access to low-cost finance for SEM start-up businesses (e.g., promoting a policy for national development banks to provide credit lines for greening businesses);
- Training for business start-ups and for BAU businesses on SEM practices and sound business management; and
- Assisting in enterprise diversification to benefit from ES (e.g., encourage use of NTFPs to increase forest SEM revenues for community forestry enterprises).

Clusters as a Business Development Tool

Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, and associated institutions in a particular field that are present in a nation or region. Clusters arise because they increase the productivity with which companies can compete. The development and upgrading of clusters is an important agenda for governments, companies, and other institutions.

Cluster development initiatives are an important new direction in economic policy, building on earlier efforts in macroeconomic stabilization, privatization, market opening, and reducing the costs of doing business.

The Harvard Institute for Strategy and Competitiveness

Support certification — the market mechanism that, through price premiums, can capture ES benefits — with marketing, access to markets, information, and training. At a sub-national level, support **clusters** and **cluster development** for green business (see Box 5.1).

Additionally, establish regulations so that market mechanisms pay for the maintenance of ES and both buyers and sellers benefit from transactions such as PES, wetland mitigation and habitat banking, and greenhouse gas cap and trade schemes, among others.

Strengthen institutional capacity building that will be needed to support these efforts in public sector agencies, as well as in participating business and civil society actors.

Augment Public Sector Revenues from Use of Ecosystem Services
Increase revenues to the state from use of ES and resources that influence ES provision. Revenue policies should properly price the resources and ensure adequate budgets for essential management functions. For example, in fisheries, the combination of fees, tariffs, and taxes should assure funding for such things as regular stock assessments, other operational research, planning and decision-making processes, stakeholder involvement, surveillance and enforcement, management capacity building, and similar tasks. Sources of such funding would be increases in fees or tariffs for forest concessions and timber stumpage, for fishery licenses, for permitting tourism installations and operations, and so forth.

Price resources such as water, timber, NTFPs, fisheries, and tourist attractions to reflect growing scarcity and externalities from use, as well as to cover management costs for each kind of natural resource. Proper pricing has the double benefit of signaling ES value and increasing public revenues that can be invested in ES maintenance.

Generate and Capture Economic Data on Ecosystem Services

Promote the generation and capture of economic data that clearly show the past, current, and future economic costs of BAU and economic benefits of SEM and, hence, the trade-offs between BAU and SEM growth models at sectoral and enterprise levels. This data generation and capture should be done for all sectors.

Such data is needed over a long period (20-30 years), with projections of net benefit curves for different management approaches. This action implies improving the utilization of ES valuation beyond current ecosystem-focused data.

To make well-informed decisions, **policy and decision-makers need a cost benefit analysis that includes a sensible time dimension to account for ES depletion or enhancement and that includes off-site costs and benefits.** This need requires that data be generated by research institutions in the region, that compare the costs and benefits of BAU and SEM by productive activity, down to the enterprise and management activity level. These studies should include an assessment of the transferability of findings from site-based research to other places and situations. Studies should be done across several sites to identify commonalities and differences, and to establish what variables and conditions permit modeling, as well as to assess risk and the costs of ES depletion in other places.

Research is also needed to estimate the costs of transitioning from BAU to SEM within each sector. This research needs to be done at the production and supply chain levels within countries. Such costing exercises should identify both high- and low-cost changes — sectoral policies, land-use planning, and regulations — so that countries can focus on low cost (high impact) mechanisms for change. In addition to economic valuation, development of more modeling

on ES — sectoral output relationships, particularly on thresholds, uncertainty, and risk — is needed. Site-based observations should also be used. A range of ecosystem models are available (Plagányi 2007). For example, ecosystem models (such as Ecopath with Ecosim, and Atlantis) provide a framework for exploring the ecosystem impacts of alternative fisheries management options.

It will be wise to start with relatively simple models that focus on key interactions rather than full ecosystem models. In the early stages, these models should be seen as exploratory. Models will help identify important interactions, provide new insights on the ecosystem effects of economic activities, and guide further empirical research; but this process will take some time before ecosystem models can be used as predictive management tools. The wide range of possible relationships for key functional responses, such as those between predators and prey or between forest conversion and water supply, generates a great deal of uncertainty in model output. An incremental exploratory approach, starting with relatively few ecosystem elements, and then building on this exploration, offers a way forward.

Additionally government institutions should develop systems to generate systematic, regular information on the following areas:

- Economic losses incurred by ES depletion identified in environmental impact assessments (EIAs) of large development projects, to quantify un-mitigatable environmental impacts. EIAs should generate and capture the economic value of ES involved to inform compensation payments for non-mitigatable impacts;
- Public sector revenues from SEM models, especially increased revenues from protected areas as well as from fisheries, forest and tourism concessions, and water; All should be priced properly;
- ES benefits to each sector, in terms of the following economic indicators:
 - Employment (direct, indirect; number and value of jobs),
 - Current and potential revenues,
 - Cost of inputs for production,
 - Productivity (return on labor land, capital versus ES) and production (volume, value),
 - Avoided damage costs (direct and indirect), and
 - Exports and foreign investment.
- Damage costs from loss of soil fertility, water quality, and other key ES.

In general, decision makers need a more cautious approach in addressing the use and depletion of ES. Lack of information, coupled with the potentially huge costs associated with irreversible damages, plays in favor of SEM. Governments in LAC should establish early warning centers or mechanisms to monitor and predict opportunely the imminent risk of ES collapse and ensuing losses.

Way Forward

LAC is learning about the contribution of ES to economic growth and equity. Natural capital has brought tremendous wealth to the region. Countries in the LAC region now need to consider the balance between short-term needs and maintenance of ES to support long-term economic growth. The region faces many opportunities and challenges in accessing new markets and responding to increased global demand for ES and environmentally-friendly products. But action is needed now to transition from BAU to SEM, before the region's potential is further eroded.

This Report offers a perspective on situations, production practices, and actions that are feasible to put into practice and that can make SEM a profitable path to the future. Most importantly, due to the variety of situations faced, this Report has constructed a way of comparing production practices between BAU and SEM within a framework for analysis and decision making in a given situation. It is now up to governments, business, NGOs, and research institutions to elaborate on and continue with such economic valuation analysis, feeding this information into policy dialogue and into action within countries across the region.



PART III

SECTORAL ANALYSIS AND FINDINGS

CHAPTER 6

AGRICULTURE

Camille Bann¹⁶

6.1 INTRODUCTION

This chapter explores the links between ecosystem services (ES) and agricultural productivity in Latin America and the Caribbean (LAC). Where feasible, the discussion presents, in economic terms, the contribution of ES to agriculture, the social and agricultural costs of poor management of ES, and the opportunities that harnessing these services present to farmers and to society. Both cropping and animal production systems are covered, as are actors from smallholders to large agribusinesses.

Agricultural production depends on the provision of ES such as water, microclimates, soil fertility, pest control, and pollination. The quality and quantity of these ES, in turn, depend on management of natural (or semi-natural) ecosystems. For example, pollination of many crops depends on sufficient, suitable habitat in landscapes surrounding the cropland to maintain viable pollinator populations. Many crops depend on streams or rivers for water provision; whether or not these streams retain adequate flow depends, in part, on proper management of the upper catchments of the watershed. The implication is that what happens to ecosystems and to their ability to provide ES will significantly affect agricultural productivity.

Agriculturally valuable ES influence both where and how people choose to farm. For example, many fruit-producing regions in temperate zones are located downwind of large bodies of water that help regulate local temperatures (Zhang et al. 2007), reducing the risk of damage from late frosts. All the major cereal grain producing regions of the South

American pampas are located on deep topsoil with high organic matter and good water-holding capacity (Zhang et al. 2007). ES to agriculture affect not only the location and type of farming, but also land values. Economic viability of agricultural land depends, in part, on production costs linked to ES such as soil fertility and depth, climate, and natural pest control (Roka and Palmquist 1997).

Agriculture, in turn, provides ES, particularly provisioning services but also cultural and regulating services. Many factors influence what ES a given agricultural system provides, including what is being produced, how the land is prepared, how the land is managed, and where the system is located. There is broad scope for reducing the impact of agricultural production on ES, or even for enhancing the provision of a given service (e.g., carbon sequestration) by changing the ways in which production systems are managed. Where the ES provided by agriculture are also inputs to the production process, they can increase profits or attract additional sources of revenue, such as payments for watershed protection or for tourism.

Key Findings

Across LAC the agricultural sector makes a significant contribution to GDP, export revenues, employment, and rural livelihoods: From 2000 to 2007, agricultural sector contributions to GDP averaged 9.6% for the region, while agricultural exports were 44% of total LAC exports for 2007. About 9% of the region's population is employed in agriculture, the primary source of income for rural households.

The agriculture sector is central to tackling poverty: Many Latin American countries have rural poverty levels above 50%. As the lead-

¹⁶ Consultant.

ing land use and employer in rural areas, agriculture is a key income source for households, central to addressing poverty with jobs and affordable food supply.

Agriculture's role in LAC economies and the welfare of its peoples depends on ES: For example, 73% of water use in LAC is for agriculture; 8.5 million hectares of crops in the region require irrigation, making water supply critical. Nutrient cycling, microclimate, pollination, and pest control are other key natural services.

Critical ES cannot be easily replaced: Many ES are free inputs to farm production. If degraded or lost, these ecological services need to be replaced by human intervention — chemical, mechanical, or biological (e.g., losses in soil fertility may be compensated with fertilizers). Yet, some ES cannot be substituted cost effectively. Without them, agricultural systems are liable to lose productivity or even collapse.

Unsustainable practices impose costs on farms and society: Unsustainable agriculture incurs external costs like habitat loss, water pollution, and soil erosion. More than 50% of the forest lands cleared for livestock have later been abandoned; in one study, the cost of soil nutrient depletion was estimated at \$169 per hectare-year (Pelletreau 2004). Negative feedback loops — poor agricultural practices diminish ES, which in turn undercuts agricultural potential — reduce future returns.

Sustainable farming practices to maintain ES can be financially viable: There are many examples of the economic superiority of sustainable farming practices such as agroforestry and organic production. SEM not only protects the environment but also can raise productivity and profits. Such advantages are specific to a growing set of production and market circumstances, however.

Barriers restrict uptake of SEM: SEM is not as widely practiced as it might be due to obstacles including high start-up costs, long lead times, and lack of funding or technical skills.

Successful SEM requires a compatible policy environment: Existing policies often encourage overuse and degradation of ES. The external impacts of agriculture on ES are seldom taken into account. Long-term agricultural yields can be improved by adopting policies to encourage SEM.

A broader understanding of the ES afforded to society by lands and ecosystems can increase economic opportunities available to farmers and improve rural livelihoods: Agricultural land not only provides food, but if well managed can deliver services such as carbon sequestration, water quality regulation, and biodiversity conservation. Payment for ES (PES) and certification for organic and fair trade products are ways to increase returns from SEM, thus facilitating uptake of these practices.

Optimal governance for management of ES requires co-ordination across Ministries: Many key ES originate outside the farm gate. The way that surrounding landscapes are managed will affect agricultural

productivity and benefits to society. Better interagency co-ordination, stakeholder engagement, and involvement of civil society is needed.

Organization of Chapter

This chapter is organized into three main parts.

Part 1 describes the links between agriculture, development, and the environment, the importance of agriculture to national economies of the region in terms of GDP creation, export earning, and jobs, and presents an overview of ES provided to and by agriculture along with the analytical framework adopted in this report.

Part 2 is focused on the economic evidence of the costs associated with unsustainable agricultural practices (categorized as Business as Usual, BAU) and the financial and economic benefits of sustainable options (categorized as Sustainable Ecosystem Management, SEM).

Part 3 discusses the opportunities and constraints surrounding the uptake of SEM practices, and presents conclusions and recommendations.

Part 1—Ecosystem Services and the Agriculture Sector

6.2 LINKING AGRICULTURE, DEVELOPMENT, AND ECOSYSTEM SERVICES

Agriculture, development, and ecosystem services (ES) are inextricably linked. Agriculture is the principal user of water and land, and, therefore, has a significant impact on a country's natural resource base. The agricultural sector of countries such as Argentina, Brazil, and Uruguay appropriates up to half the total natural resources used to support the population, while in Venezuela, Costa Rica, and Panama, the sector uses about a quarter of them (Collen et al. 2008). Sustainable agricultural practices are needed to maintain the natural resource base and ensure long-term viability of farms.

Historically, extension of the agricultural frontier has driven biodiversity loss since farmers have looked to expansion rather than intensification as a means to increase production (Harvey et al. 2004)] About 10-20% of natural grasslands and forests worldwide are expected to be converted, mostly to agriculture, over the next 40 years if business as usual (BAU) continues. Land conversion will be greatest in low income countries and dry regions (MA 2005). In LAC, pressure on biodiversity from land conversion is likely to rise due to population growth, food demand, and productivity constraints on existing farmlands (Scherr and McNeely 2002; Meijerink and Roza 2007).

Land conversion leads to substantial, sometimes irreversible, changes to ecosystem services. On-farm impacts include fragmentation of

remaining natural habitats, loss of landscape connectivity, and biodiversity degradation. Other effects are off-farm: pollution and sedimentation of waterways, greenhouse gas release, loss of wild species, land races, and the escape of invasive species and genotypes, among others. Agriculture may also impact ES indirectly via changes in ecological processes (e.g., water, fire, and nutrient cycles in addition to pest dynamics) and affect infrastructure in ways that reduce its value (Harvey et al. 2005).

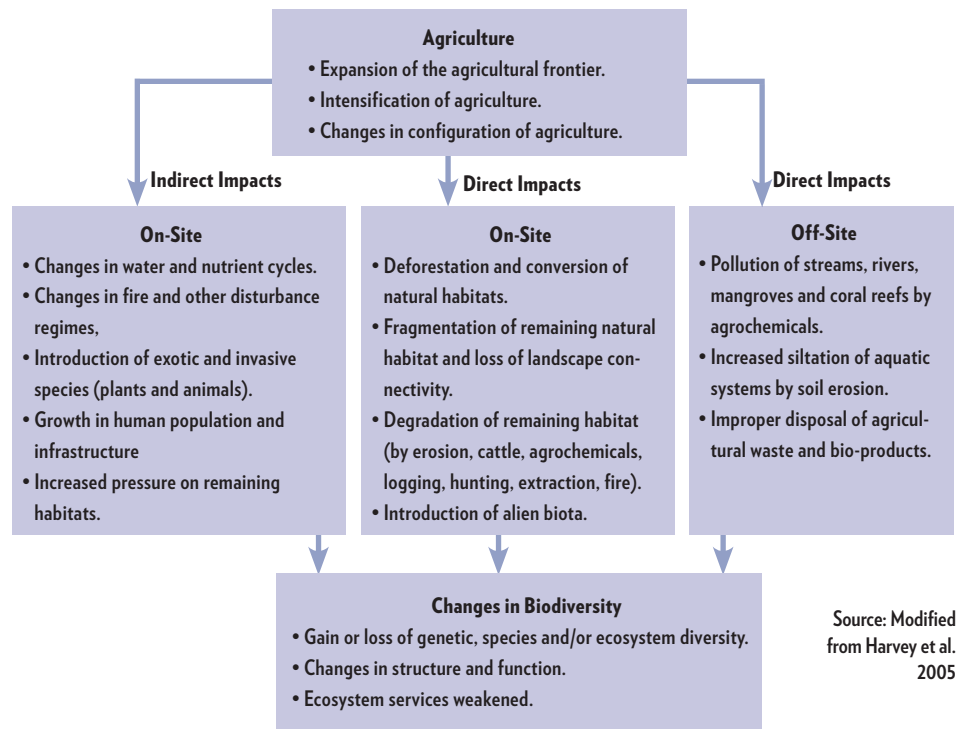
To show how agriculture can affect biodiversity conservation and ecosystem services in LAC, Harvey et al. (2005) traced three main tendencies in Central America: (1) expansion of the agricultural frontier into forested areas, (2) intensification of agricultural production by enhanced use of industrial inputs (agrochemicals, manufactured seeds, machinery), and (3) changes in the configuration of agricultural landscapes due to rotation or replacement of farming systems. These tendencies have both direct and indirect impacts (Figure 6.1). Many of these impacts refer to negative feedback loops in which current practices undermine many of the very ES that agriculture needs.

The impacts of agriculture on biodiversity and ES summarized in Figure 6.1 are mostly negative: they represent ways in which agricultural practices are undermining future agricultural processes. They arise from a dynamic relationship between agriculture and its natural and social environments; this relationship can generate both positive and negative feedback, as diagrammed in Figure 6.2. ES are captured by farming firms or households and converted by some productive process into food and fiber. Green arrows imply enterprise level responsibility, intention, and positive influence. These are enterprise level production and investment decisions. For example, the abundance, variety, and quality of food products are strongly influenced by the manner in which capital inputs of several sorts, including the natural capital of ES, are combined in productive processes to create them.

Potential feedback loops arise from the way food production and investment decisions can facilitate or hinder future production, and also broaden or narrow the opportunities available to society. Positive feedback is illustrated with the blue arrow emanating from the production process to improve both ES and the broader unintended outcomes of production decisions.

Similarly, uninformed or poor decisions about ES used in food and fi-

Figure 6.1: Agriculture and Ecosystem Services: Direct and Indirect Impacts



Source: Modified from Harvey et al. 2005

ber production can damage the future stock and flow of ES, causing a drain on the resource base and on the potential of the productive enterprise and the broader society. For example, pests, disease control, carbon sequestration, climate effects, pollination, and waste decomposition are ES that are affected by the type of production system chosen, its scale, location, capital resources, and so forth. Their value can be seen in term of avoided costs: of a pest outbreak averted, of commercial pollination services not needed, or of water treatment plants postponed. If such ES are damaged by the ways in which agriculture is carried out (e.g., in ways suggested by Figure 6.1), then future food and fiber production will be negatively affected.

In Figure 6.2, negative feedback loops are analogous to the positive ones in their potential to influence both future production decisions and broader society. These negative feedback loops are illustrated with the red arrows descending from the production process and influencing both ES and the broader unintended outcomes of production decisions. Red arrows imply responsibility, but not necessarily intention; they often give rise to externalized costs.

Agricultural Land Use in LAC

Compared to other regions of the world, agriculture in Latin America is practiced extensively; as a “land-rich” region, this makes economic sense. On average, 32% of LAC is covered by agricultural land; how-

ever, that varies considerably across the region. For example agriculture is the dominant land use for nine countries including Uruguay (83%) and El Salvador (74%) but accounts for 1% or less of land area in French Guiana, Suriname, and The Bahamas (see Annex 1).

The Role of Agriculture in LAC National Economies

Agriculture's Share of GDP and Exports

Table 6.1 shows agriculture's GDP contribution in 2007. The average for the region is 9.6%, ranging from 0.5% in Trinidad and Tobago to 25% in Guyana and Paraguay. In absolute terms, the range is from \$348 million (Dominica) to \$807 billion (Brazil).

Agriculture's contribution to trade flows is significant, far outweighing its importance as a percentage of GDP. On average, agricultural exports were 44% of LAC's total export value in 2007. For individual countries, they ranged from under 5% to over 80% of total commodity exports; countries with over 50% agricultural exports were Argentina, Paraguay, Uruguay, Belize, Honduras, and Nicaragua. In the Caribbean, while most countries were below the LAC average, in Saint Vincent and the Grenadines and Jamaica 43% of total exports were agricultural. Major export products included soybeans, coffee, banana, meat, and sugar (Table 6.1).

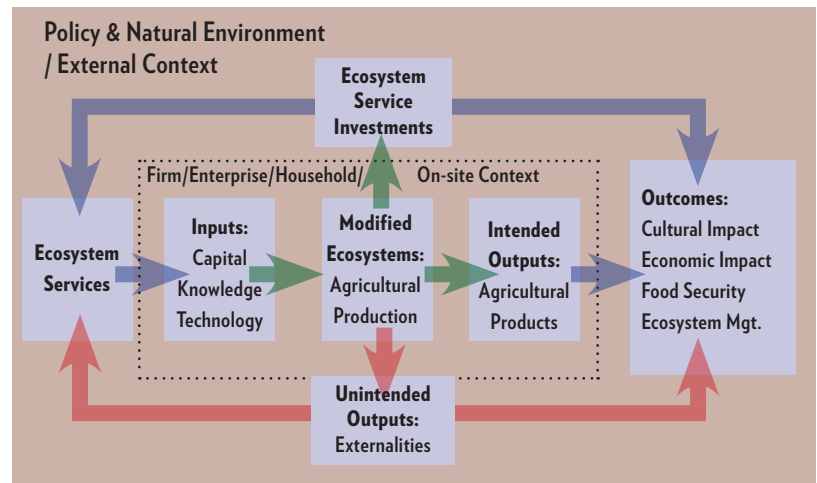
Several regional agricultural subsectors with strong comparative advantage have sustained spectacular growth — soybeans in the Southern Cone, fruits and salmon in Chile, vegetables in Guatemala and Peru, cut flowers in Colombia and Ecuador, and bananas in Ecuador. The agribusiness and food services sectors of these countries are large in national GDP signifying strong forward linkages (World Bank 2008). Other areas with high agricultural benefits in LAC included the coast of Chile (grapes) and parts of Argentina, Uruguay, and southeastern Brazil (livestock) (Naidoo and Iwamura 2007).

While agricultural products have provided the region with some of its most successful exports, concerns have been raised over environmental effects, as with soybeans in Brazil and cut flowers in Ecuador and Columbia. Sustainable management of export crops, taking into account the ES that support them, will be a growing issue for the future.

AGRICULTURE'S CONTRIBUTION TO JOB CREATION AND POVERTY ALLEVIATION

Agriculture is a key employer and source of income in the region, especially in rural areas. Between 8% and 9% of the population in LAC works in agriculture. Over 50% of the population of the Caribbean

Figure 6.2: Ecosystem services & agriculture: a dynamic relationship.



lives in rural areas, compared to 40% in Central America and Mexico, and 20% of South America. Agriculture contributes significantly to rural incomes in many countries, e.g., 42% in Nicaragua, 47% Guatemala, and 48% El Salvador (World Bank 2008). The portion of households dependent on agriculture (Table 6.1) ranges from 3% in The Bahamas to 60% in Haiti; the LAC median is 20%.

Poverty levels are high. In South and Central America the majority of countries have poverty levels over 33% (Table 6.1). Countries with higher levels of poverty often also have a large share of GDP coming from agriculture (e.g., Bolivia, Paraguay, Guatemala, Nicaragua, and Honduras). Agriculture, central to land use and employment in rural areas, has a key role in maintaining livelihoods through jobs and provision of affordable food.

6.3 ROLE OF BIODIVERSITY AND ECOSYSTEM SERVICES IN THE AGRICULTURE SECTOR

Overview of Ecosystem Services

The Millennium Ecosystem Assessment (MA) (2005) provides a framework to help identify ES (ES). The assessment includes **provisioning services** such as food and water; **regulating services** such as control of floods, drought, land degradation, and disease; **supporting services** such as soil formation and nutrient cycling; and **cultural services** such as recreational, spiritual, religious, and other nonmaterial benefits.

Agricultural ecosystems are primarily managed to provide food, fiber, and fuel. In the process, they depend upon a wide variety of ecosystem provisioning, regulating, and supporting services, such as water supply, sunlight incidence, microclimate, soil fertility, pollination, natural

TABLE 6.1. OVERVIEW OF GDP, AGRICULTURAL EXPORTS, POVERTY LEVELS, AND AGRICULTURAL EMPLOYMENT

REGION / COUNTRY	SHARE OF GDP (%) (2007 UNLESS STATED)	REAL GDP MILLIONS OF \$ (2007)	% OF AGRICULTURAL EXPORTS	MAIN EXPORTS	POPULATION IN POVERTY (% 2009)	POPULATION DEPENDENT ON AGRICULTURE (%) ¹
SOUTH AMERICA						
ARGENTINA	8 (2006)	369,365	51	Soy & soy oil	Na	8
BOLIVIA	11	10,715	16	Wheat flour & soybeans	64	40
BRAZIL	4	807,080	28	Soybeans & bird meat	33	11
CHILE	4 (2006)	102,102	15	Fresh grapes, apples, pears	14	14
COLOMBIA	10	113,517	19	Coffee & cut flowers	47	15
ECUADOR	7	21,977	30	Bananas & cut flowers	43	20
PARAGUAY	25	8,909	83	Soybeans & maize	60	30
PERU	6	76,741	14	Coffee & vegetables	44	24
URUGUAY	9	24,878	56	Bovine meat & rice	Na	10
VENEZUELA	4 (2004)	159,955	Na	Seeds and oily fruits	30	6
CENTRAL AMERICA						
BELIZE	12 (2006)	1,168	64	Fruit juice, sugar	Na	24
COSTA RICA	8	22,410	32	Bananas & pineapples	19	16
EL SALVADOR	10	15,941	42	Coffee, sugar	47	27
GUATEMALA	12 (2005)	24,914	39	Coffee, sugar	60	43
HONDURAS	12 (2006)	10,093	52	Coffee & bananas	71	27
NICARAGUA	17	4,970	81	Coffee & cattle (meat)	69 (2001)	44
MEXICO	3	687,783	5	Tomatoes, other vegetables	32	18
THE CARIBBEAN						
ANTIGUA & BARBUDA	3 (2004)	912	2	Vegetable products	Na	20
THE BAHAMAS	Na	4,938 (2002)	16	Citrus	Na	16
BARBADOS	3 (2005)	Na	29	Sugar & soy oil	Na	3
DOMINICA	15 (2005)	348	0	Bird meat & mile	Na	21
DOMINICAN REPUBLIC	12	28,100	36	Sugar, cocoa	44	12
GRENADA	5 (2006)	466	0	Wheat flour, aromatic seeds (nutmeg, cardamom)	Na	21
GUYANA	25 (2005)	818	Na	Sugar, rice	Na	15
HAITI	Na	3,953	0	n/a	Na	59
JAMAICA	3 (2004)	9,102	43	Sugar, maize	Na	18
SAINT KITTS & NEVIS	2 (2005)	419	0	Live animals	Na	21
SAINT LUCIA	3 (2005)	779	0	Bananas	Na	20
ST VINCENT & GRENADINES	7 (2005)	449	43	Bananas Wheat flour	Na	21
SURINAME	5 (2006)	1,316	0	Na	Na	17
Trinidad & Tobago	0.5 (2006)	14,629	Na	Fruit juice	Na	7

¹ This comprises all persons economically active in agriculture, as well as their non-working dependents.

SOURCE: ICCA (2008).

pest control, and plant growth and carbon fixation processes (Zhang et al. 2007). These ES determine the underlying biophysical capacity of agro-ecosystems (Wood et al. 2000). Some of these services can be substituted by man-made inputs (e.g., fertilizer, flood mitigation works). In other cases, no replacement is possible, making these ES not just inputs, but irreplaceable ‘life support’ facilities for agricultural activity.

The flow of ES depends not only on management of agro-ecosystems on-site, but also on the diversity, functioning, and management of the landscape in which these services are embedded (Zhang et al. 2007). Many organisms that provide services to agriculture do not inhabit agricultural fields, but live in the surrounding landscape; these organisms may move between natural habitats, hedgerows, and fields. Poor management at either scale can cause negative externalities that in the long run reduce productivity, increase costs, and impact society -- like diffuse pollution of waterways, over-abstraction of water, soil erosion, and climate change. The following sections describe the ES provided to and by agriculture, and how management of agricultural lands and surrounding landscapes can affect these systems.

PROVISIONING

Provisioning services are usually thought of as the products people obtain from ecosystems, such as food. Here, the focus will be on those used by agriculture: natural inputs, such as fresh water, nutrients, and genetic resources (MA 2005). Some of the main ones are discussed in turn below.

Water supply is affected by farm management decisions on abstraction and irrigation practices, agrochemical use, soil conservation, and disposal of wastes. Negative feedback loops from agricultural water use are all too common. Crops and livestock depend on reliable sources of sufficiently clean water. In turn, ground and surface waters are influenced by agriculture as to both the quality and quantity of water available for its own purposes, for other human uses, and for wild ecosystems downstream.

Nutrient and energy availability: Agriculture is highly dependent on those natural processes that make nutritious pasturage available to grazers and browsers, and sunlight and nutrients to crop plants. Such ES are taken for granted until circumstances restrict them as, for instance, when dust storms or agricultural smog shade the sun, coat leaves, and disrupt metabolism.

Genetic resources: Agriculture is heavily reliant on genetic diversity, the raw material for natural and artificial selection. It is vital to productivity maintenance; many crops could not retain commercial status without regular genetic input from wild relatives (de Groot et al. 2002). Genetic diversity at the crop level can also enhance biomass output per land unit by better utilization of nutrients and reduced losses to pests and diseases (Zhang et al. 2007). Low genetic diversity makes crops susceptible to epidemics and catastrophic losses (Zhang et al. 2007). Genetic resources provided both by and to agriculture thus serve to ameliorate risk as well as to increase production.

Box 6.1 Water Use for Agriculture

In LAC, 73% of water withdrawn from surface or underground sources is devoted to agriculture, similar to the worldwide average. However, there are countries within the region where irrigated agriculture’s share of total water use is more than 90%, as in Uruguay and Guyana. For many Caribbean islands, agriculture’s share of total water is 20% or below. In general, the agricultural sector demands considerably more water than do the domestic and industrial sectors (see Table). These estimates are based on irrigated agriculture only and do not include rain-fed farming systems, which represent about 80% of world’s agricultural land (Varghese 2009).

For Latin America, lands under irrigation increased by 36% between 1980 and 2007. In 2007, around 17.3 million hectares were irrigated representing about 11% of Latin America’s cultivated area. For the Caribbean, the growth in irrigated land was 24% (1980-2007), so that 19% of cultivated land in the Caribbean was irrigated (FAO 2009). Rice and other cereals are the main irrigated crops in LAC, representing 58% of the irrigated area. In Central America and the Greater Antilles, pasture and fodder account for more than 50% of irrigated land; half the demand for irrigated land in Latin America is for livestock production (Steinfeld et al. 2009). In the Southern Cone, fruits, vineyards, and citrus are the crops with the most area under irrigation. Growth of irrigation may portend water scarcity, severely affecting food production (Rosegrant et al. 2002; FAO 2006b in Steinfeld et al. 2009).

AGRICULTURE’S SHARE OF TOTAL WATER USE IN LAC

SUB-REGION	KM ³ OF WATER	% OF TOTAL
MEXICO	60,3	78 %
CENTRAL AMERICA	9,4	77 %
GREATER ANTILLES	11,7	75 %
GUYANA	1,8	96 %
ANDEAN	36,5	73 %
BRAZIL	33,4	61 %
SOUTHERN CONE	39,4	91 %
LAC	192,7	73 %
WORLD	2310,5	71 %
LAC AS % OF WORLD	8,3	

* Internal renewable Water Resources

Source: FAO 2010.

REGULATING SERVICES

Regulating services are obtained from a balance of ecosystem processes, including air quality maintenance, climate regulation, erosion control, restraint of pests and diseases, and water purification (MA 2005). Regulating services are among the most diverse ES provided to agriculture. Agricultural landscapes are affected by and contribute to the population dynamics of pollinators, pests, pathogens, and wildlife, as well as by fluctuations in soil loss, water quality and supply, greenhouse gas emissions, and carbon sequestration. Some examples:

Flood regulation is an ES provided to and by agriculture. Intact ecosystems are critical elements in natural flood control, slowing the accumulation of waters in rivers, protecting banks and natural levees, slowing and channeling currents, buffering storm surges along coasts, and more. Agricultural land can similarly alleviate flooding by storing waters, increasing infiltration and slowing overland flow — or conversely, worsen infiltration and flow attributes. Poor management of agricultural lands and supporting landscapes (such as upland areas and wetlands) can contribute to flooding of farms and other areas downstream. Soil compaction and vegetation removal increase down-slope flow rates and can add to local flooding, sedimentation, and downstream risk.

Climate regulation, both local and global, is another ES. Favorable microclimates — temperature, precipitation, and wind regimes — confer advantages to farms. Stability of suitable local climates relies in part on atmospheric regulation that is influenced by the functioning of agricultural ecosystems and their supporting landscapes. Agriculture is vulnerable to climate change, be it local or global; yet farming practices contribute to greenhouse gases: up to one third of worldwide CO₂ emissions and the largest part of methane (from livestock and flood rice) and nitrous oxides (primarily from fertilizers). Conversion of forest for agriculture is a major source of CO₂ release. Agriculture can also be an important carbon sink, storing it both above and below ground. In addition, farming practices can offer options to adapt to climate change.

Disease, pest, and waste control: Bacteria, fungi, and arthropods have roles in both the damage caused by some of these organisms and the vital pest and disease control services supplied by others. They decompose wastes, thus recycling nutrients and reducing exposure to pests and disease — providing ES of significant economic value to the livestock industry, among others (Zang et al. 2007). Natural control of pests is carried out by generalist and specialist predators and parasitoids, including birds, bats, spiders, beetles, bugs, mantids, flies, and wasps, as well as microorganisms (Zang et al. 2007). This ES in the short term suppresses damage and improves yield, while contributing to many long-term ecological equilibria that prevent pest and disease organisms from reaching plague status (Zhang et al. 2007). The conservation of natural enemies of crop pests underpins Integrated Pest Management (IPM), providing self-renewing pest control that is easily disrupted during agricultural intensification (African Pollinator Initiative Secretariat 2003).

SUPPORTING SERVICES

Supporting services are those necessary to produce other ES, such as primary production, liberation of oxygen, and soil formation (MA 2005). Supporting services provided to agriculture include soil structure and fertility, pollination, nutrient cycling, and primary production.

Soil structure and fertility: Soil is formed through disintegration of rock, accretion of organic matter, and release of minerals. Soil formation usually is a slow process; natural soils may be generated at a rate of only a few centimeters per century. After erosion, soil regeneration from bedrock can take 100 to 400 years (Pimentel and Wilson 1997). Given that time scale, soil may be seen as a non-renewable resource in many situations.

ES derived from soil formation relate to the maintenance of crop productivity on cultivated lands and the integrity and functioning of natural ecosystems (de Groot et al. 2002). Soil structure and fertility play a large role in determining where different kinds of farming take place and the quantity and quality of agricultural output (Zhang et al. 2007). Soils are increasingly recognized as a multi-functional resource that provides additional ES such as drinking water purification, biodiversity provision, a CO₂ sink, and important cultural services (Montanarella 2008).

Soils are extremely diverse, with properties can vary abruptly or change slowly over extensive gradients. The effects of soil degradation, through erosion, nutrient depletion, pollution, compaction, loss of biodiversity, etc. — impact not only on-site fertility and crop yields, but also off-site aspects like silting of infrastructure, CO₂ release, food and water contamination, and increased risk of flooding and landslides (Montanarella 2008). Soil degradation is exacerbated by unsustainable agricultural practices and varies greatly with soil type, technology, and rainfall.

Pollination is perhaps the best known ES performed by insects (Losey and Vaughan 2006). Production of 75% of the world's most important crops and 35% of its food depends on animal pollination (Klein et al. 2007). Bees are the best known, but birds, bats, butterflies, beetles, flies, and other insects are also important. Wild pollinators may nest in fields (e.g., ground nesting bees), or fly from nesting sites in nearby habitats to pollinate crops (Ricketts 2004). Pollination from natural vectors improves productivity and, in some cases, the quality of the product. Insect pollinators are essential for many fruit and vegetable crops; demand for pollinators grows as agricultural productivity increases. Development of larger fields and simplified landscapes for agriculture carries the risk of removing pollinator habitats (African Pollinator Initiative Secretariat 2003). Conserving wild pollinators in habitats adjacent to agriculture improves both the level and stability of pollination, raising yields, and income (Klein et al. 2003).

Nutrient cycling: Life on earth depends on the continuous cycling of 30 to 40 of the 90 chemical elements that occur in nature. Many aspects of natural ecosystems facilitate nutrient cycling at local and global scales. For example, soil organisms decompose organic mat-

ter, releasing nutrients to plant growth, to ground water, and to the atmosphere. Migration of insects, birds, fish, and mammals helps move nutrients among ecosystems. ES derived from nutrient cycling are related to soil maintenance and to regulation of gases, climate, and water (de Groot et al. 2002).

CULTURAL SERVICES

Cultural services are nonmaterial benefits people obtain from natural and agricultural ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences (MA 2005). These cultural ES both influence agriculture and help shape the socio-economic environment for this production sector. Commonly found values include appreciation for open space, rural views, and the cultural heritage of rural lifestyles, recreational hunting, and tourism. In Guatemala, Mayan spiritual values — connection to ancestors and nature — are expressed by cultivating maize, even a few stalks in the city. These ES are largely unvalued in the market economy (Swinton et al. 2007) but can be highly esteemed by individuals — who may be moved to defend biodiversity or to consume certified products.

6.4 ANALYTICAL FRAMEWORK

This section presents a framework for analyzing the costs and benefits of fostering sustainable use of ES by adopting sustainable management practices for agro-ecosystems. Two broad approaches are contrasted: Business as Usual (BAU) and Sustainable Ecosystem Management (SEM). The two approaches have positive and negative impacts, both short- and long-term impacts, on agricultural productivity, yields, social benefits, and in particular on ES. In theory, these impacts can be assigned value to estimate the import of the economic benefits and costs to agriculture and society.

BAU and SEM are not seen as diametrically opposed. Rather, the thesis of this chapter is that, while BAU may have been appropriate in the early phase of agricultural development and growth in LAC, as open spaces fill, ecosystem processes become stressed, and externalization of off-site impacts becomes less feasible, shifts toward SEM will begin to make sense — and that regional experience with SEM methods, their favorable results, and the rising costs of BAU have brought that transition moment close to hand.

Defining BAU and SEM for Agriculture IN LAC

BAU

Business As Usual (BAU) refers to agricultural practices that are common and have built the agricultural sector to the dimensions reported

above, carried out by agribusiness, large export plantations, and family enterprise of all sizes. These practices share a focus on attaining near-term financial results based on both on-farm costs and agricultural processes. Decision making does not take into account externalized costs, the value of ES that underpin production processes, nor the effects of off-site impacts (like fish kills from waters polluted by pesticide). While such systems can realize good profits in the short run, these BAU systems impose costs on society (externalities); in the longer term, their productivity is likely to be undermined by depletion of or damage to the ES they depend on.

The BAU approach does not consider relations among production decisions, environment, and broader social goals. BAU practices can be sub-optimal because they overuse natural resources, cause unnecessary pollution or waste, do not maintain their resource base, nor align with broader social and cultural objectives. BAU systems, thus, tend to have high environmental impact and low sustainability, but are often attractive for their earnings levels, at least initially.

SEM

Sustainable Ecosystem Management (SEM) refers to agricultural practices that leverage natural processes to produce long-lasting returns at attractive levels. This approach of natural leverage implies a movement from BAU practices toward other practices that are economically efficient over the long term, thereby internalizing the negative impacts of production on the natural resource base and on society. SEM approaches mitigate negative environmental externalities or avoid these “bads” altogether.

The basic SEM approach is to move from high to low impact production schemes, diversify farming systems, and rationalize the agricultural landscape. Among SEM options are soil and water conservation practices, use of polycultures and multi-cropping regimes, organic growing, and adoption of low-till or no-till production, integrated pest management, and agroforestry systems. Low impact management focuses on better use of ES, with more efficient, carefully targeted use of agrochemicals, minimizing pesticide use, and reducing runoff, erosion, and discharge of pollutants into streams. Such changes will often provide economic benefits by reducing the cost of inputs. Configuration of the agricultural landscape is another option: it may make economic sense to conserve fragile or degraded areas as natural habitat or woodlots and to locate cultivated plots where the slopes, soil, and production conditions are appropriate (Harvey et al. 2005). Organization and empowerment of communities or producers associations: these strategies are often used to support the process of change, since isolated efforts provide few opportunities for synergy, economies of scale, and sharing knowledge — isolated efforts are prone to failure.

The distinction between BAU and SEM applies to both large-scale commercial farming and to smallholders. The broad effects of SEM practices are to maintain and strengthen ES of many types (Pagiola 1998).

Table 6.2 illustrates the environmental impacts associated with BAU for some key commodities and potential management practices to mitigate those effects in a transition toward SEM.

Part II: Economic Analysis of LAC Agriculture

Many agricultural production practices are unsustainable. In the long term, these practices are likely to have economic consequences for both individual farmers and national economies. Part II looks at the economic costs associated with BAU practices in the region and the economic benefits of moving toward sustainable production practices.

TABLE 6.2. BAU IMPACTS VS SEM MANAGEMENT PRACTICES

COMMODITY	BAU - MAJOR ENVIRONMENT IMPACT	SEM - POTENTIAL MANAGEMENT PRACTICES
BANANAS	<ul style="list-style-type: none"> • Conversion of primary forest • Soil erosion and degradation • Worker exposure to pesticides • Agrochemical use and runoff • Solid wastes • Water use and pollution 	<ul style="list-style-type: none"> • Manage plantations for continuous cultivation • Reduce agrochemical use (e.g., fertilizers and pesticides) • Take appropriate integrated pest management programs • Reduce packaging materials; produce on site when possible • Reduce wastes and dispose of them correctly • Use sediment ponds to control runoff • Enforce preservation of riparian buffer zones
CATTLE	<ul style="list-style-type: none"> • Habitat conversion • Overgrazing • Feedlot production • Production of feed grains • Soil compaction, loss of fertility • Methane greenhouse gas release 	<ul style="list-style-type: none"> • Site and construction operations well planned, sustainable • Avoid overgrazing; rotate pasture use • Protect riparian areas • Improve assimilation of feeds • Improve water management • Reduce use of chemicals and antibiotics • Produce cattle with less fat and leaner meat • Encourage integrated farms with higher carrying capacity • Improve pasture management and rotations • Protect or improve water quality
CASSAVA	<ul style="list-style-type: none"> • Habitat conversion • Soil erosion and degradation 	<ul style="list-style-type: none"> • Recover existing habitat rather than converting anew • Reduce soil erosion (use of cover crops, low tillage systems)
COCOA	<ul style="list-style-type: none"> • Conversion of primary forest • Soil erosion and degradation • Agrochemical use and runoff 	<ul style="list-style-type: none"> • Shape the expansion and maintain the viability of shade cocoa • Increase efficiency of agrochemical use • Diversify sources of income • Reduce water use and create by-products • Encourage full-sun cocoa on degraded lands • Work with governments to control cocoa expansion • Work with purveyors to “green” the supply chain
COFFEE	<ul style="list-style-type: none"> • Conversion of forests • Contamination by agrochemicals • Worker exposure to pesticides • Effluents from processing 	<ul style="list-style-type: none"> • Halt the expansion of coffee production into natural forests • Reduce and improve use of dangerous fungicides and pesticides • Diversify production and sources of income • Incorporate fallowing strategies • Reduce inputs, such as agrochemicals, water for processing, etc.
MAIZE	<ul style="list-style-type: none"> • Habitat conversion • Soil erosion and degradation • Agrochemical inputs • Water use and pollution 	<ul style="list-style-type: none"> • Adopt conservation tillage • Increased organic matter in soil • Use microorganisms to break down excess nutrients • Use crop rotation and polyculture
SORGHUM	<ul style="list-style-type: none"> • Habitat conversion • Soil erosion and degradation • Very high agrochemical use • Poisoning of herbivores • Fire hazards 	<ul style="list-style-type: none"> • Rebuild the soil • Reduce pesticide use • Develop payments for carbon sequestration • Manage silage to avoid toxicity • Treat effluent from silage

Source: Harvey et al. 2004

6.5 COSTS OF ECOSYSTEM SERVICE DEGRADATION RESULTING FROM BAU PRACTICES

This section presents evidence of the economic costs, where available, of unsustainable agricultural practices under BAU, including impacts on surrounding landscapes and ecosystems. As discussed above, agriculture is dependent on a range of ES, which, if mismanaged, may entail losses to the sector and wider costs to society.

This section considers costs and trade-offs in five areas that have char-

acterized BAU agriculture in LAC; each exemplifies the theme of ecosystem service degradation:

- extensification in the cattle sector
- crop and livestock intensification
- soil erosion
- pesticide and other agrochemical use
- export crop plantation agriculture

Costs of Extensification in the Cattle Sector

The most important land use change in tropical Latin America over last 40 yrs has been the widespread conversion of forests to pasture land for livestock production (Harvey et al. 2005). Between 1981 and 1990, the region lost 75 million hectares of forests, most of which became cattle lands. Livestock production contributes to a gamut of environmental problems including global warming, land degradation, air and water pollution, and loss of biodiversity (FAO 2006 in Steinfeld 2009).

In the Amazon, pastures do not remain productive long, especially without proper management (Hetch 1993). The high-biomass forests survive on the poor acid soils because they have complex systems of nutrient cycling. When forests are cleared for pasture, there is a nutrient flush as elements held in the biomass are released to soils. With leaching, runoff, and soil compaction by cattle, nutrients decline rapidly to levels below those needed to maintain productive pastures. By 2006, 9.8 M ha were classified as degraded pasture land — almost 10% of the area of planted pastures and 3.0% of the area of rural establishments (Instituto Brasileiro de Geografia e Estatística 2006).

In 1985, livestock accounted for only 30% of agricultural output while taking up 63% of agricultural land in Brazil (Andersen 1997). Cattle ranching generated about \$20/ha yearly compared with \$41/ha from agriculture, reflecting the relatively low per-hectare productivity of cattle ranching.

Two decades later, cattle ranching was even more dominant. The number of head in the Amazon more than doubled, from 26 M in 1990 to 57 M in 2002 (Kaimowitz et al. 2004). The region went from having 18% of Brazil's cattle to almost a third. In fact, 80% of the growth in Brazil's livestock population in this period was in the Amazon, whereas in 2006, cattle occupied 80% of the Amazon land already in use (Greenpeace 2006) — almost six hectares of pasture for each one of cropland.

Explanations of pasture expansion include favorable markets for livestock, government-subsidized livestock credit, land-tenure policies that promote deforestation to establish property rights, and the low cost of land (Kaimowitz et al. 2004). In Mexico, decisions narrowly focused on such private market gains may lead land owners to convert tropical montane cloud forests to cattle ranches, despite substantial non-market losses to society in terms of ES (Martinez et al. 2009).

Since markets value forested land modestly in much of tropical Latin America, and felling the forest is often a convenient means to stake a claim on “unused” lands, from the private farmer perspective, raising cattle extensively by converting additional forest for pastures appears perfectly rational — more so if credit for cattle is subsidized. The price of a hectare of pasture is several times higher than for a forested hectare; forage is the only source of feed for cattle (Mertens et al. 2002). Yet, in more developed regions with older forest margins in Central and South America, farmers tend to produce livestock more intensively to avoid pasture degradation and the high cost of expansion (White et al. 2001).

In the Amazon, historically, expansion of the agricultural frontier into forest areas has been used as a “safety valve” to accommodate landless farmers. The main determinants for cattle expansion are financial, including land rents and beef prices (Frickmann et al. 2007). In Brazil, aggressive development policies implemented during the 1960-85 period distorted economic incentives. Land titles were granted in proportion to the amount of land converted. Since cattle ranching had relatively low start-up costs and, in addition, ensured very attractive government subsidies and tax breaks, ranching-conversion was an attractive way to acquire land (Andersen 1997). As land becomes scarce, the price will rise; with removal of distorting subsidies, this price increase should foster more intensive production methods.

The transition from mining forests to expand land ownership via low-intensity cattle ranching has occurred widely in LAC and run its course in many places, leading to consolidation of more sustainable practices. Almeida and Uhl (1995) compared the net present value of different land-use practices in the Amazon. The results show that, across all management approaches, pasture is less profitable than agricultural crops and actually produces negative returns under BAU. Sustainable intensive methods offer the best returns to pasture management and are more profitable than logging, but less profitable than agricultural crops. Intensive farming practices are also shown to offer greater employment opportunities across the land uses studied.

Chillo and Ojeda (2010), in a study of rotational cattle production in Mendoza, Argentina, show that productive benefits from SEM systems, where pasture land is divided into sections and each is used sequentially by the herds, followed by a fallow period, obtain 57% more beef production than traditional BAU systems. This productivity increase translates into higher net monetary benefits. This suggests how BAU practices are driven to evolve into SEM as conditions change from the frontier-style race for resources to consolidated, intensive production systems.

Cost of Crop and Livestock Intensification

As available land becomes scarce, increased focus is being placed on the intensification of agricultural practices. “Sustainable intensification” is widely seen as a viable strategy for increasing agricultural production, which reduces the pressure to open up new lands for agriculture.

Productive potential is great — witness gains in agroforestry programs or in export plantations with certified produce, such as those that have emerged for coffee, cacao, bananas, flowers, and others.

However, if not practiced sustainably, intensification can result in a number of negative impacts. Soil degradation (e.g., salinization, loss of organic matter, erosion of topsoil) and health impacts are examples of potential negative on-site environmental effects of intensive agriculture. Groundwater depletion, agrochemical pollution (e.g., pesticides) and biodiversity loss are examples of local off-site effects, or production externalities, that can result from unsustainable intensive agriculture. For example, over-pumping of groundwater has resulted in salt water intrusion of 1 km per year in coastal Hermosillo, Mexico. Greenhouse gas emissions, animal disease outbreaks, and a loss of crop genetic diversity are other examples of effects of intensive agricultural production (World Bank 2008). They are part of a set of negative feedback loops that limit net economic gains under BAU.

Use of subsidies to support BAU agriculture has been widespread. Many qualify as perverse subsidies, which distort markets and encourage externalities. Beside their use to support conversion of forest to cattle lands, discussed earlier, subsidies are often used to promote agrochemical use. The experience of fertilizer subsidies in India illustrates the far-reaching social implications of such policies (Box 6.2).

Costs of Soil Erosion

Recent evidence suggests that more than 40% of the world's agricultural land is moderately to extremely degraded, resulting in a 13% reduction in crop productivity. This can affect: (1) aggregate supply or price of agricultural output, (2) agricultural income and economic growth, (3) consumption by poor farm households, and (4) national wealth (Wood et al. 2000; Winters et al. 2004).

As a result of BAU practices, 38% of Ecuador is considered to be at high risk of degradation. Losses in soil fertility have resulted in the purchase of costly imported agrochemicals. In Guatemala, BAU agriculture is estimated to generate 299 million m³ of soil loss per year. This has resulted in sedimentation of waterways and high levels of eutrophication. The cost to recover just two lakes used for tourism — Izabal and Atitlan — exceeds \$653 million. These conditions are examples of an externalized cost of BAU.

In LAC, a country and crop-specific assessment of soil nutrient balances (i.e., the difference between soil nutrient inputs and outputs) suggests that for most crops and cropping systems the nutrient balance is negative, though depletion rates appear, in general, to be declining (Henao and Baanante 1999). The impacts of land degradation and the depletion of soil resources have profound economic implications for low-income countries, threatening prospects for economic growth and human welfare. From the farmer's perspective, on-site costs of soil erosion include increased expenditure on fertilizers, pesticides, equip-

ment, labor, and a loss of crop output. A study in Laos¹⁷ estimates the cost of lost nutrients at \$105/ha, based on the cost of replacing these nutrients with fertilizer, and notable land rental price reductions due to soil erosion, resulting in an estimated average financial cost of nutrient depletion of \$169/ha/year (Pelletreau 2004). In Costa Rica, yearly erosion from farm and pasture land removes nutrients worth 17% of the crop value and 14% of the value of livestock products (Repetto 1992). The associated costs of BAU land management are partly externalized, as downstream sedimentation; the loss in fertility comes around on the negative feedback loop in the forms reported for Laos.

Benefits and Costs of Pesticides

Cereal yields in LAC have tripled since 1960, driven, in part, by irrigation, improved crop varieties, pesticide use, and fertilizers. Cereal yields show economies of scale in Brazil and Chile, for example, with per hectare harvests increasing through the 1,000 ha size threshold. However, this increase in productivity, realized by increased purchase of inputs, comes with some important hidden costs (Muñoz-Piña and Forcada 2004).

Cole et al. (2000) analyzed the economic burden of illness from pesticide poisoning in highland Ecuador. In fifty reported cases in the Montufar region (1991-92), the estimated average treatment cost was approximately \$17/ case, which is 11 times the daily agricultural wage in the region. The agricultural workers affected by the poisoning tend to be very poor, with the costs of treatment representing a heavy financial burden (Cole et al. 2000). The Brazilian Ministry of Health estimated 263,400 cases of poisoning from pesticide exposure as of 1998. On the cost side, approximately \$47 million is spent yearly to treat pesticide poisoning in Brazil (Lins 1996 in Dasgupta 2001). Such costs, presumably mostly externalized by the firms that use the pesticides, are part of the negative feedback loops that slow progress under BAU at the societal level.

Costs of Export Crops in LAC

Agricultural crops make a significant contribution to export earnings. However, unsustainable management can lead to environmental impacts, as noted in the following examples.

Soybean is a major crop in Brazil. However, the industry is associated with destruction of natural habitat to increase cultivated areas and to develop the transportation infrastructure required, as well as with agrochemical pollution. For instance, it is estimated that paving the Cuibá-Santarém road would reduce transportation costs enough to increase the soybean cultivation area by 70%, from 120,000 km² to 205,000 km². Private economic benefits for farmers are estimated at \$180 million

¹⁷ A small, tropical Southeast Asian country.

Box 6.2. The Impacts of Fertilizer Subsidies in India

India has heavily subsidized fertilizer use for more than three decades. Increased demand and the soaring price of hydrocarbons, the main ingredient of many fertilizers, have taken India's annual subsidy bill to more than \$20 billion in 2009 from \$640 million in 1976.

These subsidies are not reflected in productivity increases; yet, these subsidies do create distortions, such as overuse of urea. Urea-use is so degrading to the soil that yields of some crops are falling. For instance, India now produces less rice per hectare than its neighbors, Pakistan, Sri Lanka, and Bangladesh. Food imports are rising. As a result, India spends almost twice as much on imported foods now as it did in 2002. Wheat imports reached 1.7 million tons in 2008, up from about 1,300 tons in 2002 (Ministry of Agriculture).

The government intends to adopt a new subsidy program in 2010, which will give farmers incentives to use a better mix of nutrients but the old subsidy on urea will remain in place. This means that farmers still have an incentive to overuse this input, with negative effects on soil quality and crop productivity.

India is unlikely to return to the days of 9% economic growth unless the country can reinvigorate its agricultural sector, on which the majority of citizens rely for a living. Recent reports show agriculture lagging behind other industries such as manufacturing and services, with growth under 2%. Double-digit food inflation (food prices rose 19% last year), and declining yields seriously threaten poorer and rural sectors.

Source: Wall Street Journal (2010).

while the real economic cost, considering environmental damage, would reach from \$762 million to \$1.9 billion (Vera-Díaz et al. 2009). This case suggests the magnitude of some externalized costs under BAU.

The **banana industry** is a source of revenue and employment in many LAC countries. For example, in Ecuador and Costa Rica, bananas were 9.3% and 7.7% of total exports in 2006, valued at \$1,282 million and \$675 million (FAOSTATS 2010). Environmental problems associated with banana production include deforestation, changes to hydrological systems, agrochemical damage, biodiversity loss, severe pest and disease infestations, and waste generation (Vargas 2006).

Commercial banana plantations are generally at altitudes below 200 m with annual rainfall levels below 4,000 mm, on sites with little or no slope. The loss of diverse tropical forest to establish banana plantations has shaped the physical and biological environments. In Costa Rica's Sarapiquí Valley, recent banana expansion has resulted in near extinction of 18 known tree species (McCracken 1998). Banana roots cannot be submerged, so marshes are drained; complex drainage systems funnel excess water from the fields (Lauer 1989). During peak rainfall, the drainage ditches increase the volume and velocity of water flowing through, aggravating downstream flooding. The drainage of the land also lowers the water table and impacts local water supplies.

Bananas for international markets can be commercially produced only on the best soils, found in alluvial plains and volcanic ash deposits. To maintain production rates, significant amounts of fertilizer are needed during the entire growth cycle (Hernandez and Witter 1996). It is estimated that 30 kg/ha/yr of pesticides are applied to plantations in Central America, ten times the level used to farm in industrialized countries (Wheat 1996). In many regions, such as the Pacific low-

lands of Costa Rica, the land has been so poisoned that posterior agricultural use is impossible.

During the mid 1980's, studies in the Valle de Estrella region of Costa Rica found residues of fungicides in wells and rivers in concentrations twice those known to cause adverse impacts to fish (Astorga 1998). In Chinandega, Nicaragua, it was found that the aquifer that supplies water to the populace is heavily contaminated by 30 different pesticides, many used on banana plantations (Wheat 1996). After heavy rains, drainage canals from banana plantations inundate nearby streams and estuaries with contaminated water and sediment, adversely impacting aquatic and marine life. During one month in 1994, five massive fish kills were reported in the Cariari banana region of Costa Rica. Deposition of sediment carrying large quantities of nutrients from fertilizer used on plantations has caused algal blooms in water bodies, decreasing the dissolved oxygen content of the water, and harming aquatic life. Sediment from banana plantations is partly responsible for the destruction of about 90% of the coral reefs along Costa Rica's Caribbean Coast (MacKerron 1993).

6.6 TOWARD SEM: NET ECONOMIC BENEFITS AND AVENUES FOR IMPROVEMENT

Numerous studies have found that crop rotation, no or low till production practices, crop residue management, and other forms of conservation agriculture have positive ecological implications (Govaerts et al. 2006, 2007a, 2007b, 2008). However, the financial case, at the

farm gate, and the broader economic case for conservation agriculture is less well documented. The following sections explore the financial and economic viability of SEM practices based on available evidence. The economic benefits of specific ES – soil fertility, water supply, pollination, and genetic resources – are presented, followed by examples of the economic benefits of specific farm practices like organic production and agro-forestry that maintain ES. Finally, two case studies compare (1) the financial viability of sustainable agricultural practices to BAU practices in Ecuador, and (2) the on- and off-site benefits of soil conservation measures in Costa Rica.

Economic Benefits from Maintaining Specific Ecosystem Services

SOIL FERTILITY

Soil degradation has economic implications both within and beyond the farm gate. The *on-farm benefits* of soil fertility can be measured based on the lost productivity avoided through the adoption of soil conservation practices. In a study of land use management in Lajeado, São José in Southern Brazil, better soil management was found to increase crop productivity. Between 1990 and 1996, maize, soybeans, beans, and tobacco production rose by 40%, 21%, 3%, and 32%, respectively. In monetary terms, total farm income increased \$98,460/yr for maize, \$56,071/yr for soybeans, \$12,272/yr for beans, and \$10,730/yr for tobacco. Investments in the form of subsidies to farmers and road improvements to encourage the uptake of erosion control practices were expected to be recovered within four years (Bassi 2002).

WATER SUPPLY

The provision of water to agriculture is a key ecosystem service. However, deriving an economic estimate of this service is complex. In LAC, irrigation water is provided free or at low cost, meaning that the market price does not provide a suitable proxy for the social cost of water. In addition, the costs of water extraction and irrigation vary depending on available technology and the water source.

There are also considerations of the effects of water abstraction and other agricultural management practices on water quantity and quality. Bassi (2002) found that reduced soil erosion, improved basic sanitation, and better management of animal waste led to a fall in the concentration of fecal coliform bacteria at two water sampling points: one in the middle of the watershed and the other at the treatment station. Water treatment costs were reduced by 50% (from \$3,000 to \$1,500/month for 750,000 m³) due to lower need for chemicals.

The value of rainwater used to feed crops is additional to the value of water abstracted for irrigation purposes. Cranford, Trivedi, and Queiroz (2010), based on a preliminary analysis, provide a lower bound estimate of the gross benefits of precipitation, related to the climate reg-

ulating services of the Amazon basin, to crops in Brazil and Paraguay at \$8 billion a year.

POLLINATION

Pollination is a key service provided to agriculture (Veddele et al. 2008). About 35% of crop production worldwide is supported by animal pollinators; this figure includes 107 fruit and vegetable crops. About 10% depend entirely on pollinators, while 75% have improved production. Worldwide, there are over 300,000 flower-visitor species; 25,000 to 30,000 of these flower-visitor species are bees. Bees, along with flies, butterflies and moths, wasps, and beetles, provide a valuable free service to agriculture, as do some bats and birds. Practices aimed at protecting these pollinator species help insure against decreased pollination services and productivity levels. Calculations of the global value of pollination services (wild and commercial) range from \$112 billion to \$200 billion annually (Kremen et al. 2007).

In LAC, pollinators play a key role in staple food crops. In Mexico, for example, pollinators take part in the production of 80% of crops for human consumption. Pollinator-dependent crops may be twice as productive as non-dependent crops, i.e., value per unit of area (Ashworth et al. 2009). The contribution of these natural pollination services to farm financial viability is significant, especially since pollination is a free service or input.

There is evidence of a potentially serious decline in pollinator populations due to changing land-use patterns (conversion and fragmentation), excessive use or inappropriate application of pesticides and other agrochemicals, climate change, and invasive species (FAO 2007).

Developing larger areas for agriculture removes habitat needed by pollinators (African Pollinator Initiative Secretariat 2003). Furthermore, the distance to natural forest affects the effectiveness of pollination by decreasing pollinator richness and reducing visitation rates (Ricketts et al. 2008). In Costa Rica, coffee yields in areas within 1 km of forests can be up to 20% higher than in places located far from the forest on the same farm (Ricketts et al. 2004). This difference represents a net benefit of \$229/ha-year. In the case of the farm evaluated, total income would have been 7% higher if the entire plantation were located within 1 km of a natural forest. Pollination not only increased coffee productivity but also enhanced berry weight and reduced the frequency of misshapen seeds. Olschewski et al. (2006) also conclude that coffee plantations close to natural forest patches have a higher productivity due to the pollination services they receive. At a distance of 1,500 m, yields and gross revenues declined by 45% and net revenues by 93%, from \$52 to \$3/ha.

PEST CONTROL

Pest control in Mexico by bats benefits 145,000 ha of agricultural land, with a production value of 1.8 billion pesos a year (Gandara et al.

TABLE 6.3. VALUATION OF KEY ECOSYSTEM SERVICES PROVIDED TO AGRICULTURE

ECOSYSTEM SERVICES	QUANTITATIVE ESTIMATES	MONETARY ESTIMATES	THREATS
SOIL FERTILITY	Soil conservation in S. Brazil raised corn productivity 40%, soybeans 21%, beans 3%, and tobacco 32%	Soil conservation in S. Brazil raised corn productivity 40%, soybeans 21%, beans 3%, and tobacco 32%	Poor land management practices both on- and off-farm that result in soil degradation or erosion
WATER / CLIMATE REGULATION SERVICES	73% of water used is devoted to agriculture	73% of water used is devoted to agriculture	Increasing demand/ over-abstraction Intensification of irrigation Water pollution caused by point and diffuse sources including agricultural ones
POLLINATION	35% of plant based crops worldwide supported by animal pollinators	35% of plant based crops worldwide supported by animal pollinators	Changing land use Agro chemicals Climate change Invasive species
GENETIC RESOURCES	Generally maintains agriculture productivity, protects against diseases	Generally maintains agriculture productivity, protects against diseases	Land conversion Monoculture
PEST CONTROL	Bats in Mexico are estimated to reduce need for pesticides by 25-50%	Bats in Mexico are estimated to reduce need for pesticides by 25-50%	Habitat loss

2006). Bats are estimated to reduce the need for pesticides by 25%-50%; where pesticides are not used, the presence of bats reduces production losses by 55%. This natural pest control service by just one taxon is valued at between \$7 million and \$62 million a year.

Table 6.3 gives examples of the scale and value of the benefits of key ES provided to agriculture.

Economic Benefits from Specific Farm Practices to Maintain Ecosystem Services

This section looks at a range of sustainable practices and describes how they can contribute to preserve or even enhance the ES provided to agriculture. The following farm practices are discussed: organic production, agroforestry, silvopastoral systems, soil management, conservation tillage and mulching, crop rotation, riparian corridors, and crop diversification. In each case, the practice is defined, its potential ecological benefits identified, available evidence on economic results summarized, and constraints to uptake discussed.

A subtext to many of these practices is that they are useful for hillside farming. This hillside applicability is important in LAC: in the common situation, the best soils — such as fertile, relatively flat bottomlands— have been appropriated by large landholders, corporate entities, and others for commercial agriculture, often mechanized. Smallholders and subsistence farmers are largely relegated to the more problematic soils and slopes, where soil improvement and prevention of erosion are most needed, and where agro-ecological practices are most often promoted. While many of the practices discussed next can also be applied to

large-scale commercial agriculture, their use to maintain ES generally focuses on the less prosperous strata and tends to improve equity, especially when instituted in combination with community organization and empowerment.

ORGANIC PRODUCTION

Organic agriculture emphasizes use of renewable resources and conservation of soil and water. It reduces environmental risks by avoiding potentially damaging technologies such as pesticides, herbicides, synthetic fertilizers, GMO crops, and veterinary antibiotics (Scialabba 2007; Niggli et al. 2009). One difference between organic production and other “conservation” practices is its integral approach to reducing agricultural impact on ES. Organic production focuses on decreasing specific impacts while incorporating practices aimed at improving soil and water quality, and controlling weeds, pests, and diseases without using agrochemicals (Niggli et al. 2009).

The benefits of organic agriculture have been widely analyzed. Evidence suggests that under appropriate market and institutional arrangements, it has important socio-economic benefits: improved income to small farmers, enhanced food security, increased independence from imported food, and reduced needs for expensive inputs. Also, as has been shown in Europe, organic production systems demand from 10% to 70% less energy per unit area than conventional ones. Lower use of synthetic inputs means greenhouse gas emissions are less in organic systems (Niggli et al. 2009).

Productivity of organic production depends on many factors. In high-growth perennial plantations that are highly dependent on external in-

puts, conversion to organic practices frequently reduces yields by up to 50%. On the other hand, for crops on medium-growth lands with moderate synthetic inputs and in subsistence systems, organic yields may be higher than conventional ones. Organic systems require more labor and appropriate land tenure to motivate farmers to invest in their lands. For an organic agriculture sector to succeed, local markets must be well developed so that farmers are not too dependent on external markets. Food supply chains should be short to raise the growers' share in total sales gains (Scialabba 2007).

Organic agriculture is now commercially practiced in 120 countries and represents 31 million ha of certified cropland and pasture (approximately 0.7% of global agricultural land), 62 million ha of certified wild lands, and a market of \$40 billion in 2006 (2% of food retailed in developed countries). Organic production occupies 4% of arable land in Uruguay, 1.7% in Argentina, 1.5% in Chile, 1.0% in Bolivia, and 0.24% in Brazil, Colombia, and Panama (Guerreiro Barbosa and Gomes Lages, 2007). Latin America is an exporter of organic products; domestic markets are still developing.

The benefits of organic farming vary depending on the crop and the circumstances. Samaniego Sánchez (2006), for example, did not identify significant differences in soil nutrients and leaf tissue between conventional and organic production of red peppers in Costa Rica. The benefits of organic coffee production have been more widely examined and are discussed in Box 6.3.

AGROFORESTRY

Agroforestry systems are a form of multiple culture in which three conditions hold: (1) at least two species of plants exist that interact biologically, (2) at least one of the species is ligneous and perennial, and, (3) at least one species is used for agricultural aims. In the tropics, development of agroforestry systems arises from the need to produce sustainably and to support farmers and their families by diversification (Somarrriba 1998 and Long and Nair 1991 in Chaparro Grandos 2005). Since agroforestry systems can use any mix of crop and tree species, these systems can be adapted to almost any environmental, economic, and social conditions (Scherr 1991 in Haggard et al. 2004).

Agroforestry is well aligned with small-scale farming; agroforestry reduces dependence on external materials while increasing diversity. The ecological benefits of agroforestry include carbon sequestration and biodiversity protection, as well as soil improvement and erosion reduction. Other ES provided by agroforestry systems are crop pollination and water provision, food supply for humans and animals, medicinal plants, firewood, and inputs for crafts (Cerdán Cabrera 2007).

In Costa Rica, organic coffee plantations and other efforts that incorporate leguminous tree species were found to better sustain productivity levels in the face of decreasing fertilizer applications (Romero López 2006). As a result, producers incorporating these systems into their farms are better protected from the risk of high fertilizer prices or

Box 6.3. The Benefits of Organic and Fair Trade Coffee

The ecological benefits of organic coffee production have been documented in several studies. In Costa Rica and Nicaragua, comparison of various conventional systems with organic production showed that under appropriate technology organic can attain the same productivity as conventional systems (Soto 2003). Soil acidity decreased in the organic coffee regime, while phosphorous, potassium, and calcium rose. A major environmental benefit of organic coffee was reduced herbicide use. In Brazil, the adoption of organic systems in coffee improved the local environment as result of reduced use of agrochemicals and adoption of new practices to treat and recycle water used in coffee processing (Imaflora 2008). In Mexico, five years after organic farming start, 30 additional plant species of value were found on organic farms: fruit and shade trees, horticultural and medicinal crops, and other plants to prevent erosion (Scialabba and Hattam et al. 2003).

Beside ecological benefits, organic producers may enjoy financial advantages. In a feasibility study of organic coffee in Brazil, income generated on organic farms ranged from \$366 to \$2,505/ha (Guerreiro Barbosa and Gomes Lages 2007). Small scale coffee producers in Nicaragua were shown to achieve a 28% increase in net returns by their participation in certified organic coffee cooperatives, despite coffee quality not always improving (Bacon 2005). Calo and Ise (2005) concluded that in Mexico, fair trade but not organic certification allowed organic coffee producers to increase profits. Similar results were obtained in Brazil, Nicaragua, the Dominican Republic, and Guatemala (Potts 2007; Arnould and Plastina 2006). Generally, fair trade certification not only gave higher prices to farmers but also lowered market risk due to price variability and improved market access through participation in the cooperative (Bacon 2005).

Interviews with organic producers in Costa Rica showed that besides increasing income of most farmers, there were also positive effects on producer health, the atmosphere, and rural income. The study stresses the need for technical support, producer organizations, and marketing facilities because the transition is complex (Soto et al. 2003).

scarcity. Experiments conducted by CATIE in Costa Rica and Nicaragua have shown that conventional coffee production with timber species is as productive as non-shade production; productivity of low input organic systems can be enhanced by use of *Erythrina* shade trees, which increases soil nutrient recycling and nitrogen availability (Haggard et al. 2009).

A World Bank study of agroforestry systems across Central America (Current et al. 1995) found that profitability depends on site, resources, and market conditions. The 21 systems analyzed had a total value of approximately \$150 million (in 1990 dollars) and covered over 50,000 farm households. Over 40% of the agroforestry systems had significantly higher returns than traditional systems. For example, one agroforestry system had a NPV of \$2,863 per ha (over 10 years, 1992 values) compared to \$1,423 per hectare for contour planting and \$764 per hectare for woodlots. Only 10% of the agroforestry systems studied performed less well than traditional systems.

Current and Scherr (1995) analyzed 56 agroforestry systems in Central America and found that 75% had an Internal Rate of Return (IRR) of at least 20%, with two thirds having higher NPV and returns to labor than all alternative land uses. High labor systems were profitable as long as output prices or productivity were high, but many high return systems also had high marketing risks or faced limited demand. A planting incentive or subsidy and technical assistance is usually needed to promote uptake of agroforestry (Current and Scherr 1995).

Evidence is mounting that the integration of trees and shrubs with crops and livestock into an agroforestry system increases provision of ES. This integration can “enhance soil fertility, reduce erosion, improve water quality, enhance biodiversity, increase aesthetics, and sequester carbon” (Jose 2009). As such, payments for ecosystem services (PES) have been suggested as a potential mechanism to help finance the shift from conventional agriculture to agroforestry systems. Moreover, the switch from conventional agriculture to agroforestry will not only increase delivery of ES *directly*, by switching to more sustainable agricultural land use, but also *indirectly* by decreasing pressure on surrounding forests, potentially allowing financing through avoided deforestation payments (i.e. REDD+). Examples of such PES schemes are present throughout Latin America (Pagiola et al. 2005), including Ecuador (e.g., Wunder and Albán 2008). This relationship between agroforestry and avoided deforestation will be discussed in Part III.

Issues and costs of establishing agroforestry include adaptation to local conditions, providing information and training, establishing government and project support, linking farmers to markets, securing land tenure, and ensuring the quality and diversity of planting materials (FAO 2005).

SILVOPASTORAL SYSTEMS

Silvopastoral systems are a form of agroforestry that includes animal production. More specifically, a silvopastoral system implies the presence of perennial species (trees or shrubs) interacting with traditional components (herbaceous pastures and animals) under integral handling (Pezo and Ibrahim 1999 in Chaparro Granados 2005). Among the options for silvopastoral systems are: (i) fodder banks of woody species, (ii) ligneous perennials in alleys, (iii) trees or shrubs dispersed in pasture, (iv) pasturing in timber and fruit tree plantations, (v) living barriers, and (vi) windbreak curtains.

Silvopastoral systems can reduce many negative impacts associated with traditional livestock production. The main environmental benefits include biodiversity gains, carbon sequestration, and hydrological benefits. Silvopastoral systems can host higher levels of biodiversity as a result of propagation of native forest plants under the scattered trees and provision of resources and refuge to wildlife (e.g., increased food and nest site availability to birds). These systems accumulate more carbon than conventional systems (13-15 tons/year in Costa Rica and Panama compared to 1-2 tons/year in extensive pastures). Hydrological benefits come from reduced run-off, soil erosion, and landslide risk on hills (Pagiola et al. 2007). These systems also can protect soils, enhance pasture productivity, and provide income from harvesting fruit, fuelwood, and timber.

One estimate of net present value of silvopastoral practices was only \$440/ha (50 years, 10% discount rate); estimates of their IRR range between 4 and 14 percent, depending on country and type of farm (Pagiola et al. 2004). In Costa Rica, the IRR of improved pastures ranged from 10.1% to 12.3% (12 years). In Colombia, the IRR of improved legume-based pastures ranged from 12% to 19%. In Peru, the IRR of improved pastures was 9.8% (White et al. 2001). Alonso (2000) analyzed shifting traditional dairy production to an improved silvopastoral setting in Belize, which was more profitable, both in the short and long runs. The benefit-cost ratio was 28% greater than for the traditional method after a year and 6% more after 40 years. The main factor was the lower cost of feed with silvopastoral schemes: 29% instead of 35% of production costs.

Two constraints to the adoption of silvopastoral systems are their high start-up cost and the delayed realization of benefits while the trees grow. The time needed for silvopastoral systems to start generating financial benefits depends on factors like tree species and management practices. Cash flows became positive after the third year in a silvopastoral system in Columbia (Chaparro Granados 2005) and after four years in Nicaragua (Pagiola 2004). Accordingly, policies to bridge the investment costs of silvopastoral systems, including PES generated by this system may be needed to encourage adoption. External barriers to adoption, especially by small farmers, are lack of technical assistance, credit, and land tenure (Pagiola et al. 2007).

SOIL MANAGEMENT

Soil management practices comprise a wide range of strategies aimed at conserving and improving soils. They help maintain two main ES provided to and by agriculture: soil fertility and water provision. Thus, soil management measures have both on and off-site benefits.

Many soil conservation systems recharge aquifers and reduce erosion and sedimentation; using terraces, contour planting, residue barriers, rock walls, diversion ditches, and living fences soil management practices can reduce and retain run-off by letting rainfall soak in, avoiding washing, and channeling larger currents away from fragile fields. Mulching, residue barriers, and fallen leaves add organic material, improve infiltration, and maintain humidity.

Research has shown that soil cover is the single most effective technique to prevent soil erosion caused by rainfall, thereby sustaining productivity. Increasing soil cover reduces soil break up and movement due to rain drops. Run-off velocity is lower, time is gained for soaking in, and the volume of surface run-off decreased (FAO 2000).

A study in Panama and Brazil showed that erosion in maize where soil cover was kept was a fraction (1.7%) of the soil loss under bare soil conditions. This case emphasizes the benefits of soil cover during all the crop growth cycle. Soil loss is greatest in the initial stages, due to greater soil exposure. The crop plants themselves are not as efficient as crop residues in reducing erosion (FAO 1998).

Table 6.4 estimates the net benefits of selected soil conservation practices (NPV and IRR). The data show that the benefits are site specific and depend on crop, soil, and site factors. For some areas (e.g., Barva and Tierra Blanca in Costa Rica, El Naranjal in the Dominican Republic, and Patzité in Guatemala), the practices evaluated were not profitable, while in other places (Turubares, Costa Rica; Maissade, Haiti; Tatumbula and Yorito in Honduras; and Coclé, Panamá) the same practices were highly cost-effective. In these cases, soil conservation practices were beneficial when the soils are at low productivity levels. In areas where soil productivity is close to “breakdown,” all soil preservation measures were profitable. For soils that are almost completely depleted, conservation measures give financial returns from the first year, as in the case of Maissade in Haiti. In contrast, conservation practices on soils that are more than 100 years away from losing their productivity, due to their intrinsic characteristics (e.g., deep volcanic ash), may not result in income gains for farmers.

ORGANIC SOIL AMENDMENTS

The use of cover crops, green manures, and composting adds organic matter to the soil by incorporating crop residues, adding nutrients and increasing fertility at relatively low cost. In tropical rain-fed agriculture where farmers have limited resources and soils are decreasing in fertility, conditions prevalent in much of LAC, restoring organic matter to soils is essential to stabilizing production (FAO 2001).

Incorporating organic amendments to soils is not new to LAC farmers. Such practices have been passed down through the generations in many countries. An example is Quesungual, a practice named after the Honduran community where this traditional amendment practice was first encountered. Quesungual consists of pruning trees, adding the stubble to hillsides where corn and beans are to be planted, and burning the stubble before seeding. Major benefits perceived by farmers are

TABLE 6.4. ESTIMATED NET BENEFITS OF SOIL CONSERVATION IN CENTRAL AMERICA

COUNTRY AND AREA	CONSERVATION MEASURE	CROP	NET PRESENT VALUE (\$) ¹	INTERNAL RATE OF RETURN (%)	YEARS TO SOIL BREAKDOWN
COSTA RICA BARVA	Diversion ditches	Coffee	-920	<0	>100
TIERRA BLANCA	Diversion ditches	Potatoes	-3340	<0	>100
TURRUBARES	Diversion ditches	Coco yam	1110	84,2	2
TURRUBARES	Terraces	Coco yam	4140	60,2	3
DOMINICAN REPUBLIC EL NARANJAL	Diversion ditches	Pigeon peas, peanuts, beans	-132	16,9	>100
GUATEMALA PATZITÉ	Terraces	Corn	-156	16,5	>100
HAITI MAISSADE	Residue barriers	Corn, sorghum	1180	Positive ²	0
	Rock walls	Corn, sorghum	956	Positive ²	1
HONDURAS TATUMBLA	Diversion ditches	Corn	909	56,5	4
YORITO	Diversion ditches	Corn	83	21,9	18
PANAMA COCLÉ	Terraces	Rice, corn, yucca, beans	34	27,2	8

Source: Case studies in Lutz, Pagiola, and Reiche (1994b).

¹ Net present value is computed over fifty years, using a 20% real discount rate.

² Undefined, because net returns are positive from year one onward.

increased crop productivity and greater resilience to floods (crops under the system showed no major damage after hurricane Mitch). Under Quesungual, maize produced 1.9 t/ha-year compared to half that from other “traditional” methods (FAO 2005). The system is associated with reduced erosion, better water retention, and increased agro-diversity (Gamboa et al. 2009).

CONSERVATION TILLAGE AND MULCHING

Tillage covers a wide range of activities that change the physical characteristics of the soil before planting. Conservation tillage refers to practices that reduce soil degradation and water loss compared to conventional methods. Usually, soil is not turned and crop residues are maintained (FAO 2000). In addition, conservation tillage may reduce carbon emissions (Pautsch et al. 2000). Mulching incorporates crop residues or other vegetative matter into the soil (FAO 2000). Mulching protects the surface of the soil from intensive rains, sun, and wind, helps infiltration, lowers run-off, and improves soil organic matter and structure.

Several levels of conservation tillage are distinguished by the extent to which the soil is distorted after harvesting the previous crop. The most environmentally beneficial is zero tillage (no till or direct drilling), which

does not disturb the soil except as needed for seeding. Reduced tillage refers to tilling the whole surface but eliminating one or more operations that would have been performed under conventional tillage. One system consists of conventionally preparing the rows where seeds are to be planted and leaving the inter-rows undisturbed.

Govaerts et al. (2007) compared soils in Mexico's highlands after five years of implementing different practices. Conservation tillage with residue retention proved to be the best practice to improve soil organic matter content, soil stability, and water infiltration. Furthermore, benefits increased with the amount of residue added. Benefits were evident at both 5 and 12 years, suggesting that conservation tillage and mounding are a sustainable production alternative for sub-tropical highlands.

CROP ROTATION, POLY CULTURES, AND DIVERSIFICATION

These three practices reflect the same basic idea: synergy from crop plant diversity. Crop rotation helps protect ES by preserving soil quality and controlling pests, weeds, and diseases while lowering the need for chemical inputs. In many cases specific sequences of crops and fallows have been devised to help fields and agro-ecosystems recuperate after a season or two with a demanding primary crop (often a cash crop that allows soil degradation and/or pest build-ups).

Similar ends are pursued by using polycultures, combinations of crops that can be grown simultaneously in the same field. Productivity gains of maize in polyculture with squash and beans, relative to maize monoculture, are well known; many other examples are in the literature.

In the face of adverse shocks, crop diversity can play an important role in maintaining yields. Thus, highly diverse agricultural systems can generate significant resilience benefits. This is true both in the sense of incorporation of multiple species into farming systems and in terms of within-crop genetic diversity. Pérez (2004) found that Brazilian households with greater agricultural diversity have significantly higher agricultural incomes, as well as lower variations in their income.

INTEGRATED PEST MANAGEMENT (IPM)

Integrated pest management (IPM) is a long run, ecosystem-based approach to control of pests and reduction of their impact. Pest suppression is achieved by use of biological control, plant varieties that naturally resist pests, cultivating, pruning, fertilizing and irrigation practices that reduce pest problems, and pest-unfriendly habitat change. Implementing an IPM strategy requires knowledge of pests and their life cycles, environmental requirements, and natural enemies. Pesticides are a last resort. When used, the least toxic and most target-specific products are chosen. Regular, systematic survey of pest presence and damage levels is needed (Flint and Molinar 2003; Flint 2008).

IPM can be combined with other strategies within a conservation agriculture production scheme. IPM has proved cost effective in increasing

productivity in crops such as maize, coffee, rice, cassava (FAO 2001), among many others. For example, in Peru, 40% of potato farmers participating in an IPM project reported net annual savings of at least \$19 due to use of IPM, 30% declared savings between \$20 and \$30; and the remaining 30% achieved gains of more than \$40 (per farm, not per ha). Insect pest damage reportedly decreased in 79% of participating farms (Chiri et al. 1997).

RIPARIAN CORRIDORS

Riparian corridors are the land areas bordering rivers and streams. Often left in natural vegetation, they are used as a way of compensating the damage caused by land fragmentation and habitat loss, sometimes serving to connect patches of natural habitat on the landscape. These land areas provide several ES to agriculture by reducing flooding and soil erosion, improving and increasing water quality and quantity, and serving as groundwater rechargers. Stream corridors constitute some of the most productive habitats in terms of biodiversity (USDA 2010) which can be associated with improvement in the provision of pollination, and water and soil fertility ES to agriculture. Riparian corridors can be combined with other conservation practices such as terraces and filter strips, which increase infiltration capacity, in turn, facilitating groundwater recharge.

SUMMARY

Table 6.5 summarizes the conservation practices discussed earlier drawing out their potential ecological and economic benefits, and the barriers to their implementation that could be targeted by policy initiatives to promote their uptake.

Agribusiness

Movement toward SEM is important for small-scale agriculture and agribusiness alike. In fact, when investment costs are high, businesses are in a better position to assume these costs and to reap the benefits. There is evidence that SEM can be profitable for high-productivity monoculture plantations. For example, organic maize and soybean production has been shown to compete with conventional farming (Pimentel et al. 2005 and Mäder et al. 2002 in Niggli et al. 2009). Even small changes that do not imply high costs can increase profitability at the industrial level. For example, cotton productivity in Brazil was improved by introducing a no-tillage system with cattle and poultry manure (de Lacerda and Silva 2007). Consumers are an important driver in increasing sustainability of some agro-industries, as are big marketing firms with the clout to demand better conditions due to the market power they exercise.

Key agribusiness crops in LAC include sugar, beef, and palm oil, as summarized below. Other crops, not treated here for reasons of space, have made successful transitions to SEM in at least some places, such as pineapples, bananas, and soy.

TABLE 2. SUMMARY OF THE ECOLOGICAL AND ECONOMIC BENEFITS OF SEM

FARM PRACTICE	ECOLOGICAL BENEFITS	ECONOMIC BENEFITS	POTENTIAL BARRIERS
ORGANIC PRODUCTION	Reduces environmental risks by reducing use of chemical inputs Demands less energy per unit of area Lower green house emissions	Raises, stabilizes income to poor farmers. Nicaragua - certified organic coffee producer' income increased by 40% Enhance food security and increase independence from imported food sources and expensive agricultural inputs Certification (gets price premium)	Benefits vary by crop Lower yields with high growth crops that use external inputs Labor requirements Land tenure (many non-owners) Underdeveloped local markets
AGROFORESTRY	Carbon sequestration Biodiversity protection Soil improvements Crop pollination Water provision	Central America - 90% of agroforestry systems resulted in higher returns than traditional cultivation - i.e., an NPV of \$2,863 (over 10 years) compared to \$1,423 obtained from contour planting BAU and \$764 from woodlot	High marketing risk Lower returns in early years mean start up incentives are required Success rate depends on site, resource and market conditions
SILVOPASTORAL SYSTEMS	Carbon sequestration Biodiversity protection Soil improvements Crop pollination Water provision	Systems in Belize shown to be more profitable than traditional systems Timber and fruit products for domestic consumption and/or sell	High establishment costs Time lag before benefits start Lack of technical assistance Credit constraints Poor land tenure conditions
SOIL MANAGEMENT	Soil fertility Water provision	Southern Brazil, better soil management and greater use of green and organic manure increased total farm income by \$98,460/yr for maize; \$56,071/yr for soybean; \$12,272/yr for beans and \$10,730/yr, tobacco.	High costs associated with some practices. Farmers do not perceive the need to adopt soil conservation practices on deep soil.
ORGANIC COMPOSTING	Adds nitrogen to soils Reduced soil erosion Improved water retention Increased agro-diversity	Honduras - Maize productivity doubled to 1.9 t ha year-1 from 0.95 t ha year-1 for traditional corn production system	Low barriers Labor requirements may be relatively high
CONSERVATION TILLAGE AND MULCHING	Improved physical, chemical & biological soil properties. Reduced carbon emissions Reduced soil degradation and loss	Increased net returns to farmers.	Might not be economically viable for small producers without technical and financial support
CROP ROTATION, POLY-CULTURE, AND CROP DIVERSIFICATION	Biomass production increase Soil quality preservation Natural control of pests, weeds, disease Higher crop resilience Reduced risk	Mexico - maize productivity increases between 47% and 74% with respect to monoculture when combined with beans and squash Increased farm productivity Brazil - higher, less variable income	Lower productivity of some crops compared to yields in monoculture Seed company uniformity with improved seed supply
INTEGRATED PEST MANAGEMENT	Minimal use of chemical pesticides Better overall control of pests	Proved cost effective in increasing productivity in crops such as maize, coffee, rice, and cassava	Knowledge of pests, life cycles, environmental needs & natural enemies Long run strategy (requires time to achieve potential)
RIPARIAN CORRIDORS	Decrease damage from land fragmentation, habitat loss Improves ES provision: pollination, water and soil fertility	Increases in productivity	Riverside lands often have prime soils, invite BAU uses

SUGAR

In 2008, Brazil's share of world sugar production was 33%, followed by Mexico, Colombia, and Guatemala with 3.2%, 2.3% and 1.6%, respectively (UNDP 2010a). A significant part of the sugar produced by each of these countries is exported. In Brazil, the cane industry employs over a million workers and represents 16.5% of agricultural GDP and 2.5% of total GDP (UNDP 2010a).

Environmental pressures from sugar production include deforestation, habitat degradation, soil erosion, water pollution by agrochemicals, and carbon emissions (UNDP 2010a). However, there have been initiatives to encourage social and environmental sustainability of the industry: Walmart and some banks refuse to do business with produc-

ers that adopt practices that may endanger human-health or degrade the environment. Other buyers, such as Coca Cola, have joined better management practices initiatives that entail more responsible sugar production (UNDP 2010a).

SEM practices reduce soil degradation and air and water pollution, and foster biodiversity. Eliminating pre-harvest burning of sugarcane fields can raise productivity by 5%. In addition, organic matter build-up (mulching) can further increase production, raising the benefits of not burning. Importantly, these initiatives do not compromise productivity and profits. For example, in India the production cost of conventional sugar is about \$925/ha compared to \$783/ha under SEM (15% less). Returns rise both from lower production costs and price premiums (UNDP 2010a).

BEEF

Brazil, Argentina, and Mexico are among the world's top 10 beef producers representing some 14% of global production in 2000. Brazil, although not the largest producer, is the leading exporter with 28% of global exports in 2006 (UNDP 2010c).

The beef industry is concentrated in a few companies. Production is dominated by Marfrig Group, Grupo JBS, Tyson Foods, Cargill, ConAgra, and US Beef Premium. These firms sell beef and cattle by-products to the top processing brands. A few of these conglomerates and their clients have begun to push for a more sustainable beef industry. Nike, for instance, is refusing to buy leather from deforested areas (UNDP 2010c).

Silvopastoral systems offer potential opportunities for more sustainable beef production. Due to their high establishment cost, silvopastoral systems have not been widely adopted by small producers, but represent a good opportunity to agro-industry entrepreneurs. Producers can benefit from these systems through enhanced soil conditions and fertility, which translates into higher incomes. In addition, silvopastoral production can reduce risk by diversifying pasture lands with timber.

PALM OIL

Palm oil is concentrated in large-scale plantations ranging from 400 to 72,900 ha. The oil's main use in foods is as cooking oil and in products from margarine to cookies. Non-food uses include cleaning and personal-use products, and biofuel production. Corporations like Procter & Gamble, Cargill, and Nestle use palm oil; Unilever alone buys about 4% of world supply (UNDP 2010b). Colombia is the main producer in LAC, although Costa Rica, Mexico, Nicaragua, and Ecuador also have plantations. Colombia's production has grown since the 1990's, reaching a 2% world market share in 2005.

Environmental problems related to palm oil include agrochemical use, high demand for water, deforestation (palm oil is considered one of the main drivers of deforestation), and release of greenhouse gases. SEM agricultural practices focus on soil conservation, integrated pest management, and habitat management to increase connectivity between plantations, wildlife corridors, and protected areas, including purchase of lands and habitat restoration to strengthen the latter (UNDP 2010b).

Conclusion: Benefits of SEM

The evidence is strong that SEM has environmental advantages over BAU and that these environmental advantages are often associated with financial benefits. SEM internalizes environmental externalities, thereby maintaining environmental quality and not undermining the free ES provided to agriculture by nature, which are key production inputs. ES degradation implies costs both to farmers (e.g., increased fertilizer use) and society (e.g., silt removal from reservoirs), which can be reduced via SEM.

There is evidence that environmentally-friendly production practices,

such as conservation tillage and agroforestry, provide higher financial and economic returns than do BAU practices. Two important themes emerge. First, the viability of SEM is dependent on factors such as crop and soil type, resource availability (e.g., labor), and market conditions. Many of the conditions for SEM accumulate under BAU, as resources become increasingly scarce, environments fill in, markets are consolidated, and societies mature. The financial and economic viability of SEM needs to be examined in each case, taking into consideration all the factors that will affect the chosen SEM approach and the stage of opportunity that has been attained. Second, increased uptake of SEM in agriculture is likely to require public and/or private sector investment and creative policy incentives to overcome current barriers, including high start-up costs, low returns in the early years, lack of technical awareness among farmers, poor access to credit, and uncertain land-tenure arrangements.

6.7 SUSTAINABLE ENVIRONMENTAL MANAGEMENT: CASES AND RESULTS

Studies to illustrate key points of the chapter have been gathered and, where needed, commissioned by UNDP. Summaries of original commissioned papers appear as Case Studies; those of previously published work appear in text boxes.

Agroforestry in the Intag River Region of Ecuador¹⁸

This case study compares the financial viability of three SEM systems — mixed agroforestry, shade-grown coffee, and sustainable forestry — to BAU practices in the Intag River region of Ecuador.

In the northwestern Andes, the Intag River region covers 150,000 ha, with 17,000 people living in 90 communities (Earth Economics 2008). The vegetation goes from sub-tropical forest to páramo, ranging over 1,500m-4,000m in altitude. Cloud forests cover 44,000 ha (Hidro Intag 2009), valued for their high biodiversity and regulation of water quality and supply (Bubb et al. 2004).

In Latin America, 90% of cloud forests are threatened by agriculture (Bubb et al. 2004). In Andean Ecuador, deforestation is largely due to demand for agricultural and cattle ranching land (Wunder 1996). It is understood that “the future of cloud forests is inextricably tied up with the future livelihoods of the farmers in the surrounding areas” (Bubb et al. 2004). The case of Intag suggests that those livelihoods can be maintained and even improved through SEM.

¹⁸ Prepared by Matthew Cranford (Department of Geography and Environment and the Grantham Institute on Climate Change and the Environment, the London School of Economics and Political Science, UK; corresponding author: <m.c.cranford@lse.ac.uk>), Jose Cueva (Consorcio Toisán, Ecuador), and Dr. Mika Peck (Rainforest Concern, UK; Department of Biology and Environmental Science, University of Sussex, UK).

TABLE 6.6. VALUE OF VARIOUS CONVENTIONAL AGRICULTURAL SYSTEMS, IN \$ PER HA

AGRICULTURAL SYSTEM	AVERAGE ANNUAL PROFIT (UNDISCOUNTED)	NET PRESENT VALUE (5% DISCOUNT RATE)		
		15 YEARS	25 YEARS	30 YEARS
TREE TOMATO	1,160 ¹	12,642	17,166	18,724
	1,138 ²	12,403	16,841	18,369
MIXED, MAIZE AND BEAN	973 ²	10,604	14,399	15,705
	350 ^{1,2}	3,815	5,180	5,649
BEAN	270	2,943	3,996	4,358

Sources: ¹Martinet (2006) and ²Tafur and Gaybor (2006).

COMPARING BAU AGRICULTURE WITH SEM IN INTAG

Profitability of BAU practices is assessed in Table 6.6. A study of agricultural practices in the Cristopamba River micro-watershed (Tafur and Gaybor 2008) identified seven types of privately-owned production systems, based on size and products raised. Profits in 2006 (before depreciation) averaged \$113-\$1,138/ha. The most profitable system was micro-scale (<6 ha) tree tomato production (\$1,138/ha), followed by small (6-30 ha) and micro-scale systems that include some tree tomatoes, but are focused on maize and beans. These two systems accrued an average profit of \$973/ha and \$350/ha, respectively. These results agree in large part with another study of the same area that estimated the annual undiscounted value of tree tomato production to be \$1160/ha and mixed maize and bean systems to be \$350-\$970/ha (Martinet 2006 as cited in Earth Economics 2008). As a lower-bound estimate of the profitability of current practices, pure bean systems earn \$270/ha each year. The most common conventional system is a mixed system, which, based on upper-bound estimates, has an NPV of \$10,605, \$14,399, and \$15,707 per hectare over 15, 25, and 30 years, respectively.

The Concorcio Toisán (an association of various NGOs and producer groups in Intag) has developed financial models for alternative, sustainable agricultural practices: mixed agroforestry and shade-grown coffee. The models are based on local knowledge and experience, including over 10 years of experiments with agroforestry and reforestation. These models have been adapted *ex-post* to the format of economic cost-benefit analysis (CBA), based on a one-hectare parcel of land, a 5% discount rate, and a 5% interest rate on credit received. It is assumed that income is prioritized to repay credit first, before the farmer receives any profit; further, that credit is received on an as-needed basis, precisely covering the costs incurred in the initial years before net income is large enough to pay off credit and cover costs.

The forecasted average annual profit (given as present value) for each land use is \$1,696 for agroforestry, \$1,330 for shade-grown coffee, and \$1,216 for sustainable forestry (Table 6.7). The results indicate that each sustainable system is more profitable than any conventional sys-

tem in the region. Notably, these results are conservative compared to Martinet (2006), who estimated the undiscounted annual value of coffee¹⁹ and mixed fruit production to be \$4,930 and \$9,570 per hectare respectively. The undiscounted average annual profit described by the financial model results presented here is \$3,041 for coffee and \$5,113 for mixed agroforestry.

BARRIER TO SEM

To understand the financial trade-offs between agricultural practices, it is useful to compare the changing profitability over the lifetime of the projects. Mixed agroforestry has a higher average and less variable annual profit than both other land uses, but both shade-grown coffee and sustainable forestry produce noticeably higher profits in distinct time-periods (Figure 6.3). The peaks in profitability over different timeframes suggest that setting aside different sections of a farm for different sustainable land uses would help provide a more stable cash flow for farmers, and may also help hedge against the risk of failure of individual crops.

While SEM may be more profitable than BAU to private landholders in the long run, the forecasted profitability over time illustrates two important barriers for implementing these sustainable land uses: the need for access to credit and savings mechanisms. First, neither mixed agroforestry nor shade-grown coffee turn a profit until year four. Where conversion is not assisted or subsidized by NGOs or producer associations, access to credit would help foster uptake of these practices. Second, the models indicate that there are likely to be times beyond the initial profitable periods where costs exceed income (e.g., year nine for shade-grown coffee). These costly periods could be financed by additional credit, but because they are after profitable periods they could also be financed with farmer savings if savings institutions were accessible.

On- and Off-Site Soil Conservation Benefits in Birris Watershed, Costa Rica²⁰

Forest fragmentation and intensive agricultural production makes the Birris watershed, a tributary of the Reventazon River, one of the largest sediment-producers in the Costa Rica (Sanchez-Azofeifa et al. 2002). Average erosion rates have increased from 12 t/ha/yr prior to 1978, when only 15% of the watershed was under horticulture, to 42 t/ha/yr in the 90's when crops occupied more than 30% of the watershed (Abreu 1994; Marchamalo 2004). However, the presence of

¹⁹ It is not specified which type of coffee production system this higher value estimate is based on. Uptake of coffee-growing in the region, however, has been primarily based on shade-grown and organic practices, so it is assumed an estimate produced in 2006 is for sustainable coffee production.

²⁰ Prepared by Raffaele Vignola, Marco Otarola, Miguel Marchamalo, and Jaime Echeverria.

Figure 6.3. Forecast present value of net cash flow by year for sustainable agricultural practices in Intag

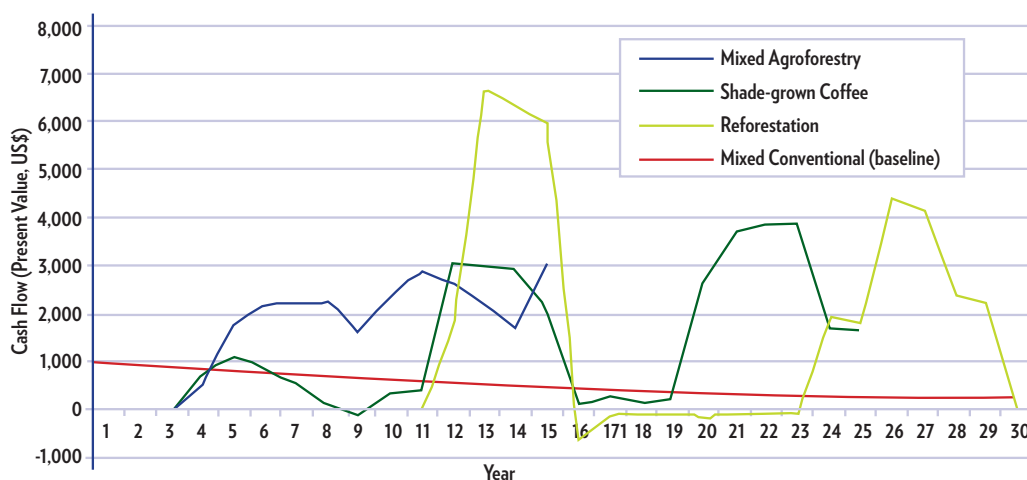


TABLE 6.7: AVERAGE ANNUAL CASH FLOW FROM LAND-USE OVER ESTIMATED TIMEFRAME, ALL VALUES IN \$ PER HECTARE

LAND USE	YEARS	PRESENT VALUE OF COSTS	PRESENT VALUE OF BENEFITS	NET PRESENT VALUE (PROFITS)	PAYBACK YEAR
		PVC	PVB	NPV=PVB-PVC	BCR=PVB/PVC
MIXED AGROFORESTRY	15	836	2,532	1,696	4
SHADE-GROWN COFFEE	25	779	2,109	1,330	4

TABLE 6.8: NPV OF LAND COVER TYPES

LAND COVER TYPES	1) BAU	2) REFORESTATION IN HRA	3) ADOPTION OF SCPs IN HRA	4) ADOPTION OF SCPs AOW
NPV of total on-site and off-site costs and benefits of soil regulation scenarios (\$)	-1,238,837	728,275	-37,387	-1,221,916

Note: PV over 20 years, 4.5% discount rate.

deep volcanic soils reduces the harm of topsoil loss to farmers, which is visible only in some places (Lutz et al. 1994a; Rodriguez 2001). Due to soil erosion and heavy rainfall, up to 1.5 million tons of sediment is removed each year from its dams at a cost of more than \$2 million (Rodriguez 2001).

Vignola et al. identify and analyze four management scenarios: (1) Business As Usual, (2) reforestation of high risk areas (HRA) for erosion control, (3) adoption of soil conservation practices only in HRA, and (4) adoption of soil conservation practices across the watershed. The soil conservation scenarios (3 & 4) are characterized by changes in soil management (e.g., increased tree cover and improved anti-erosion practices in agricultural plots). For each scenario, the following were estimated: start-up cost; the cost of replacing lost nutrients based on the Reposition Cost method, and the cost of dam-cleaning operations (e.g., energy costs, use of machinery, salaries). Table 6.8 presents the NPV of these management options.

The analysis of on-site and off-site benefits of soil regulation scenarios suggests that concentrating on reforestation in high priority areas is the most cost-effective option. However, small-holder farmers are reluctant to give up a land use that sustains their livelihood for forest cover restoration and/or protection — and rightly so. In the absence of a mechanism to reimburse farmers for their services for shifting to reforestation — to avert the off-site costs that have accrued to others under BAU — the farmers would have little motivation to do so. This raises the question of payments for environmental services (PES), covered in Part III.

Conclusion

Not only is transition from current BAU agricultural practices to SEM affordable, but this transition is also likely to be more profitable to landholders in the long run. Furthermore, implementation of these SEM practices enhances the level of ES associated with agricultural land, and also alleviates pressure on surrounding mountain forests that provide a range of ES, including some that are vital to continued economic development, such as regulation of water resources.

Part III: Moving to SEM: Opportunities and Challenges

6.8 OPPORTUNITIES

Payments for Ecosystem Services

Payments for Ecosystem Services (PES) are a means to provide compensation to those who maintain ES from those who benefit from them. For example, farmers may be paid for the adoption of water-friendly land-use practices by a local government that uses the water downstream and wishes to avoid investing far more in a water treatment plant. When management of ES benefits people outside of the country, international PES may create additional opportunities and sources of funds to encourage stewardship of these services, e.g., payment for practices that sequester greenhouse gases.

Of the many ES to which agriculture can contribute, enhanced water provision, climate change mitigation, and the preservation of biodiversity appear to be the most likely to generate PES (FAO 2007).

There has been strong interest in PES in LAC over the past decade. Costa Rica has the oldest program, initiated in 1997. To date, relatively few PES programs have targeted farmers and agricultural lands, although the demand for environmental services from agriculture is expected to increase (FAO 2007). A prominent example is China's Grain for Green program, initiated in 1999 to address concerns about erosion, water retention, and flooding. Colombia, Costa Rica, and Nicaragua have initiated a pilot PES project focused on agricultural areas wherein degraded pastures are restored as silvopastoral systems (see Box 6.4) (World Bank 2008).

There are some private PES mechanisms in agriculture. Examples include the Scolel Té project in Chiapas, Mexico, in which farmers and rural communities are paid by private individuals and firms for voluntary carbon emission offsets generated through the adoption of agroforestry practices (Tipper 2002). Other examples include eco-labeling schemes such as the SalvaNATURA certification for shade-grown coffee from El Salvador.

In cases where BAU agriculture is more profitable than SEM, PES could tip the balance in favor of SEM agriculture. However, evidence to date on the performance of PES indicates that they need to be carefully designed to be successful. Design issues include (1) measurement of the ES being provided, (2) clear demand for the service, (3) provision of payments in a way that results in the desired change, and (4) avoidance of the creation of perverse incentives or adverse side effects (Pagiola 2004).

Climate Change

The agricultural sector contributes about one third of total CO₂ emissions and is the largest source of methane (from livestock and flood rice production) and nitrous oxides (primarily from fertilizer). Conversion of forest also results in major loss of carbon stocks and its release to the atmosphere. The sector thus presents mitigation opportunities, potentially financed by PES. Carbon trading schemes, particularly for avoided deforestation and soil carbon sequestration, should be explored to reduce emissions from agricultural land-use change. Table 6.9 summarizes some current climate change mitigation practices.

Interventions to prevent conversion of land to low carbon-storing uses or to encourage shifting to a high carbon-storing land use, will contribute to net carbon storage. Agroforestry and conservation land management systems can, thus, contribute meaningfully to carbon sequestration (FAO 2007).

Payments to adopt carbon mitigation measures can make conservation agriculture attractive to farmers. In Chiapas, Mexico, some 60% of carbon credits sold at \$3.30 per ton went directly to farmers, increasing household incomes on average \$300 to \$1,800 per year (World Bank 2008). Farmer response to PES will depend on the cost of participat-

Box 6.4 Payments for Integrated Silvopastoral Systems

A project in Costa Rica, Nicaragua, and Colombia set up a PES scheme based on the degree of environmental service being provided (carbon sequestration and biodiversity). The goal was to improve degraded pastures via development of more intensive silvopastoral systems able to generate global environmental benefits as well as social and economic remuneration to producers. In each country, about 3,000 ha were enrolled in the project (Ibrahim et al., forthcoming).

Achievements were measured as change in pasture area with high tree density, which increased by 20%, 16%, and 9% in Costa Rica, Nicaragua, and Colombia, respectively; area of fodder banks used for dry season feeding (increases of about 1% in all countries); area of degraded pastures, which decreased by 13%, 21%, and 2.5%, respectively; and length of living fences, which increased between 69 and 86 m/ha. Payments were made based on yearly improvements due to adoption of silvopastoral practices as measured on an environmental service index (ESI) that combined biodiversity and carbon sequestration indices. Initial payment ascended to \$10/ESI baseline point; additional payments of \$75 per additional points were made; total payment limit for the full period of the project was set at \$6000.

There was no significant difference in the adoption rate of improved technologies between poor and non-poor farmers. Farms with the highest initial environmental index (greater biodiversity and carbon sequestration) incorporated fewer changes (Ibrahim et al. forthcoming). These findings show how a well-defined PES can engage low income farmers in sustainable environmental practices and that selection could prioritize beneficiaries based on their initial environmental status (There is ongoing debate on the validity of selecting against existing pro-conservation practitioners as PES recipients.) At the socioeconomic level, the PES scheme increased milk productivity and the gross margin from sale of cattle products, especially for poor and extremely poor farmers. There was an increase in per capita income in farms receiving PES, while herbicide use decreased between 42% and 51% (Ibrahim et al. forthcoming).

ing (including start-up costs), initial losses, and reduced agricultural production, compared to the amount received from PES.

Agriculture is highly vulnerable to changes and variability in climate, and to extreme weather events. Floods and storms have resulted in significant damages to the agriculture sector in LAC. For example, Tropical Storm Agatha (2010) destroyed an estimated \$19 million of agricultural lands

TABLE 6.9. PRACTICES TO INCREASE CARBON SEQUESTRATION AND REDUCE EMISSIONS

ECOSYSTEM SERVICE	FARM-LEVEL MANAGEMENT	LANDSCAPE-LEVEL MANAGEMENT
SEQUESTER CO ₂ IN SOIL	Manage and enrich soil organic matter Reduce frequency of cultivation Use low tillage and soil conservation practices	Organize communities and farmer associations
SEQUESTER CO ₂ IN PERENNIAL PLANTS	Increase use of perennials, farm forest management, agroforestry, natural regeneration Lengthen fallow periods	Afforestation, natural regeneration of brush and forests
EMIT LESS CO ₂	Agricultural machinery emission management Reduce burning	Reduce forest and fallow burning
EMIT LESS METHANE	Better livestock, peat soil, rice paddy management	Protect peat from disturbance

Source: FAO (2007).

in Guatemala, and Hurricane Mitch (1998) reportedly destroyed two-thirds of staple food crops and 80% of export crops in Honduras. SEM also provides ways to assist agriculture to adapt to climate change. Agroforestry systems can reduce vulnerability of smallholders to climate variability and help them adapt to changing conditions (UNFCCC 2008).

Eco-Certification

Certification can confer a price premium or expand market access; certification is a way by which benefits can be conferred for maintaining ES. Surveys indicate consumers are prepared to pay more to support growers in developing countries or to protect the global environment, provided that claim is transparent and trustworthy (Scialabba 2007). Organic, Fair Trade, Shade Grown, and other eco-certification labeling programs hold promise. These labeling programs increase returns to farmers and encourage environmental stewardship. Potential price premiums for certified products must be assessed for effects on production costs and or yields that may result from the practices required (Calo and Ise 2005).

Most eco-certification contracts improve not only agricultural practices, product quality, and prices but also farmer working conditions. For instance, in Nicaragua, certified coffee farms more often formalize their worker's conditions by signing written contracts with them; in addition, certified farms avoid child labor to a greater degree and comply with regulations related to adolescent labor. Wages are also higher in certified farms, and occupational safety and health programs are more often facilitated (Social Accountability International 2009). Other non-market benefits derived from certification include strengthening producer organizations and aiding small producers to cope with the coffee crisis (Ronchi 2002; Bacon 2005; Bacon et al. 2008; Jaffee 2007; Calo and Ise 2005; Milford 2004 in Ruben and Zuñiga 2010).

Eco-certification, such as those of the Sustainable Agriculture Network (SAN) and Forest Stewardship Council (FSC), has driven positive envi-

ronmental outcomes in LAC as well as setting standards for good farming practices (Melo and Wolf 2007; Melo 2004; Lusk et al. 2007). For example, Canadian consumers were shown to value food, including beef, produced with attention to the environment. Willingness to pay a premium was modest, though respondents who self-identified as environmentalists offered to pay 15% more (Belcher et al. 2007).

There is evidence that certified farmers receive higher incomes than those producing conventionally. In Nicaragua, Fair Trade certified farms receive, on average, prices 5% higher and, in addition, a price premium is paid to the managing organization to be used for collective purposes such as loans to women's groups and scholarships to children (Social Accountability International 2009).

Not all certification programs bring better returns to producers or positive environmental outcomes (Potts 2007). One study found premiums averaging higher for Fair Trade than for Organic, Rainforest Alliance, and Utz Kapeh certification (in descending order). Brazilian, Colombian, Costa Rican, and Guatemalan producers receive the highest certified coffee premiums, while Bolivian, Ecuadorian, and Peruvian producers receive the lowest (Killian et al. 2004). A second study found higher premiums for Fair Trade certification and significant positive environmental and production spillover effects of organic and shade-grown certifications (Ponte 2004). Another study found that Organic certification led to lower herbicide use, but Utz, Fair Trade and C.A.F.E. certified practices did not. Farms certified by Rainforest Alliance reduced use of synthetic fertilizers and increased use of organic ones (Quispe Guanica 2007). Coffee farmers may benefit from certification schemes that allow better coordination between actors in the value chain such as roasters, traders, and growers (Muradian and Pelupessy 2005). In Peru, no income differences were identified between certified and non-certified organic producers, but certified farms had higher levels of farm assets, suggesting that improved household conditions are associated with certification (Fort and Ruben 2008).

In Tabasco, Mexico, organic cocoa growing started around 1984. In 1997, a project to increase farm income while reforestation was introduced. Under this project, farmers and cooperative members widened their part in the production chain, not only growing the cocoa but also processing chocolate. While 200 to 300 farmers directly benefited from the activity, thousands more gained indirectly via on-farm processing and direct marketing (Scialabba and Hattam 2003). Experience with certified bananas is found in Box 6.5.

Maximising CO-benefits

Agricultural lands are typically managed only for production of a single commercial crop, when a range of income-generating outputs may be feasible — opportunities to capture multiple outputs, or co-benefits, from ES through sustainable agricultural practices. Agroforestry systems, for example, promote biodiversity and energy conservation and

can enhance rural employment. In addition to PES opportunities, SEM can also present options for agri-tourism and ecotourism.

The range of potential ES lost under BAU intensive cropping practices can be recovered, to some degree, through SEM with appropriate farm management. Tradeoffs will persist in some situations, but in other cases, the optimal land use may involve managing the land to capture benefits.

6.9 CHALLENGES TO SEM

Widespread uptake of SEM faces a number of challenges, explored here.

High Start-up Costs of SEM

Many sustainable agriculture practices involve up-front investments that farmers may not be in a position to finance. These practices may generate income only in the medium to long term and are, thus, unattractive. Typically, a switch to agroforestry implies low profits or even negative cash flows in the first years. A study covering 22 farms in Mexico showed that establishment costs were not recovered before year three (Haggard et al. 2004). To counteract high investment costs, producers used three approaches: planting either (1) high value crops such as chili, sesame, and sorrel in small, intensively managed areas, (2) legume cover crops to dominate weeds, or (3) perennial crops, such as annatto (Bixa), cassava, and bananas, which once established are low maintenance. The high up-front investment needed to pay for verifying certification standards may also deter farmers.

Limited access to affordable credit complicates situations where switching to SEM requires capital. In Honduras, Nicaragua, and Peru, producers facing financial constraints used 50-75% fewer purchased inputs relative to those with access to capital. The net income of the latter was 60-90% higher. Regional programs like the Poverty Reduction and Local Rural Development Program (PROLOCAL) in Ecuador and Sierra Exportadora in Peru address this constraint (WB 2007).

Private versus Social Costs

Not all conservation practices are profitable to farmers, as shown by Lutz et al. (1994a) for soil conservation practices. However, some practices non-viable from the farmer's perspective may be beneficial from the societal perspective. In situations where the public goods nature of ES prevents the land owner from capturing more value under SEM than under BAU (i.e., where the benefits of conservation exceed the costs at the societal level, but not at the farm gate) regulatory interventions by governments, as well as market-based interventions, can tip the balance in favor of SEM (recall the Birris watershed case, earlier).

Market Structure and Price Variability

Food industry consolidation characterizes BAU and creates both constraints and opportunities for the evolution of strategies to move toward SEM. Large conglomerates represent an opportunity to move quickly to SEM if large buyers motivate large producers to do so (as in the case of the international sugar, beef, and banana markets reported on earlier). At the same time, agriculture can help reduce poverty if smallholders become direct suppliers to modern food markets, good jobs are created in agro-industry, and markets for environmental services are introduced. This is an increasing challenge as the structure of the global food industry has undergone substantial change in the past 20 years, with a trend toward large producers and marketers.

Supermarkets handle 50-60% of all food retailing in Latin America. Nicaragua is the lowest in the region at 20%, while Brazil is the highest at 75% (World Bank 2008).

Smallholders risk being crowded out of livestock production by large-scale enterprises. In pork and poultry production, large units benefit from economies of scale and buyers prefer larger volumes of a consistent quality than small producers can supply. Spatial and economic concentration of production, processing, and retailing has led to larger production units, most located near urban areas. This geographical and economic consolidation of the livestock sector may make meat and milk more affordable for the urban poor and might create employment upstream and downstream of the producer, but has negative effects on the environment, animal and human health, and social equity (WB 2005).

Agricultural systems are also vulnerable to market price variability. For example, an analysis of four alternative agroforestry systems in Costa Rica concluded that the likelihood of financial success of these projects ranged greatly (from 37% to 51%) when variability in the price of beef was incorporated. This is true for most agricultural production, especially at small scale. Longer term contracts for certified produce can help stabilize prices.

The Policy Environment

Policies influence the relative costs and benefits of the inputs (including ES), outputs, and processes used to produce goods and services. Some policies correct distortions in the marketplace due to externalities or other market failures; other policies encourage them (e.g., "perverse incentives"). Common areas in which policies create environmentally-damaging market distortions include fertilizer, pesticide, and irrigation subsidies (or tax exemptions); price controls; and agricultural credit or crop insurance tied to pesticide use (Farah 1994; Dasgupta 2001). Subsidies and tax exemptions reduce the relative costs of the products they are applied to, encouraging these products to be used more intensively. Thus, these perverse incentives also

Box 6.6: Policies to Promote the SEM of Livestock Operations

Policy options to reduce environmental damage by livestock (World Bank 2008) include:

- Limiting the size (number of head) or density (head per ha) per operation or per region and imposing a minimum distance between livestock operations and waterways (Brazil);
- Tax rebates for relocation to less ecologically sensitive or less populated areas;
- Surtaxes on urban operations; and
- Investment support for environmentally sensitive technologies (reducing runoff, phosphorus, nitrogen, etc.), and cap and trade manure markets.

tend to slow the adoption of new technology. The experience of fertilizer subsidies in India illustrates the far-reaching social implications of such policies (Box 6.2, earlier).

Measures that promote SEM agriculture may be less controversial, like those underpinning certification programs, watershed level PES agreements, or involvement of stakeholders in public planning. Appropriate institutional frameworks, capable of making the policies and regulations work, are an essential element of SEM policy agendas. Policies range from general enabling provisions to detailed restrictive frameworks to guide sustainable production in specific lines of endeavor. Box 4.6 outlines an example of a policy framework to enable SEM for intensive livestock operations that under BAU contaminate the environment (e.g., feedlots; enclosed poultry, pig, and dairy farms, etc.).

Information and Access to Markets

Farmers may not be aware of the benefits of SEM farming systems, in both their environmental advantages and their potential financial superiority over current BAU practices. Dissemination of information on alternative approaches is required, along with technical assistance. Development of local markets is also important so farmers are not exclusively dependent on export markets; shorter food supply chains should be promoted in order to facilitate farmer share in commercial gain (Scialabba 2007). To participate in current agro-industrial process, local stakeholders must learn about phyto-sanitary and product standards, as well as labor and environmental norms, to be able to contract with supermarket chains as well as with export markets (Reardon 2007).

Table 6.10 summarizes the challenges facing wide-scale adoption of SEM and possible solutions to help to address these barriers.

TABLE 6.10. SEM – BARRIERS AND POSSIBLE SOLUTIONS

BARRIERS	SOLUTIONS
High start-up costs and delays to earning a return on investments	Provision of credit or other sources of finance and training to support the cost of adaption, change and technology adoption
Low on-farm profitability hinders adoption of socially beneficial practices	Raise on-farm returns from sustainable management of ES via incentives (based on social benefits of conservation initiative), such as PES; promotion of co-benefits from sustainable management
Lack of evidence on monetary value of ES	Improve evidence base by developing processes to methodologically collect data and commission valuation studies of key ES
Trend: consolidation of large agri-business buyers (supermarkets); barriers to smallholders; equity concerns	Work with supermarkets to source products from sustainable outlets, including smallholder production to address poverty and promote equity. Encourage uptake of SEM by agri business
Many current policies promote unsustainable practices	Removal of perverse incentives and introduction of positive incentives and regulations that promote SEM (e.g., PES)
Lack of information, technical knowhow and access to markets	Dissemination campaigns, technical support programs and support to get SEM products marketed

6.10 GENERAL CONCLUSIONS AND POLICY RECOMMENDATIONS

Conclusions

This chapter has shown how the agriculture sector depends on ES and how that sector can play a significant role in conserving these services by transitioning toward sustainable and equitable production systems under SEM. There are many cases where BAU is unsustainable, placing negative environmental impacts and costs on society and resulting in lower long-run economic benefits than SEM.

In comparison, SEM can facilitate growth, can be more equitable by favoring smallholders and the poor, and be affordable. However, barriers that hinder more widespread uptake of SEM need to be overcome.

These conclusions are explored below. With them, this caveat: the diversity of agricultural production systems precludes sweeping generalizations or one-size-fits-all policy solutions for the region.

SEM can facilitate growth

The agriculture sector in LAC is important to the welfare of the economies and societies of the region. The sector makes a significant contribution to GDP, employment, and rural livelihoods, as well as providing food, fiber, and fuel for household use. Productivity in the agriculture sector depends in fundamental ways on the conservation of ES: free natural services like access to water, soil fertility, pollination, and control of pests and disease. There are limits on the extent to which human-made inputs can substitute for these natural services when they are degraded. The cost of substitutes will increase as ES deteriorate, raising production costs. Maintaining food production at low cost, especially for staples, underlies the region's food security.

If SEM is not extended in the agricultural sector, the LAC region faces declines in productivity over time. This is evidenced in the costs of soil erosion, which has resulted in a 13% reduction in crop productivity worldwide. Land degradation and soil depletion could have profound economic implications for the region, threatening prospects for economic growth and future human welfare. India illustrates the risks of continuing on a BAU path; soil degradation and productivity loss has led to these problems: a hefty food import bill and food price inflation (See Box 4.2 on fertilizer subsidies in India, early in the chapter).

BAU is eventually unsustainable: While often profitable in the short term, over time with BAU, costs go up and revenues decline — and those actors react to the externalized costs they experience. Then, SEM generates greater long-term net financial and economic benefits. There are various ways in which this tendency manifests itself.

- **The standard BAU paradigm:** Under this scenario, BAU is financially superior to SEM in the short run but not necessarily in the long run. Taking into account ES degradation adds cost to BAU so that the paradigm becomes less profitable. For example, decreasing soil fertility under BAU raises fertilizer costs to farmers. Studies in Central America and the Caribbean show that while rates of degradation vary across crops and sites, in all cases, return on production gradually declines (without conservation measures). Off-site costs of soil erosion, such as siltation of dams and canals, further reduce the *economic viability* of BAU practices. These off-site costs typically remain external to private decisions without policy initiatives to ensure they are accounted for in operating costs. SEM, by comparison, maintains soil fertility and lowers fertilizer costs over time. If that happens soon enough and in large enough magnitude, SEM will be economically preferable to private decision makers even without considering the externalities.
- **Ecosystem degradation in the short term:** This scenario is similar to “the standard BAU paradigm” except the effects of ES degradation on the profitability and economic viability of BAU are felt much earlier. ES degradation adds costs to BAU

and lowers revenue in the short run, while SEM provides positive ecological feedback leading to higher revenues than in BAU systems. For example, silvopastoral systems have high start-up costs but, over time, provide higher returns supported by the co-benefits of timber and fruit products for domestic use or sale. Under BAU, in comparison, revenues start to decrease from the start due to the undercutting of the ES on which productivity is based (e.g., soil fertility, rainwater retention, and pollination services). Public policies that support the initial investment costs (technical assistance and credit) would increase the uptake of silvopastoral systems.

- **ES threshold and lost revenue:** ES may collapse, in which case BAU ceases to generate income because the productivity of the natural resource has decreased dramatically. This collapse may or may not revert back to functioning natural systems. Meanwhile, SEM practices might have resulted in lower but sustained productivity over the long-term, securing incomes for business and government. A case in point is the Amazon livestock sector, where perverse subsidies have encouraged the clearing forests for pasture. However, this land clearing has resulted in large areas of land being abandoned due to rapid loss of fertility once the nutrient cycling services of the forest are eliminated. That is a boom-bust scenario, shown to be less favorable in the long run than sustainable cattle ranching or farming. Water scarcity in some places can also lead to collapse of crops that depend on irrigation if water resources are not sustainably managed (see hydrological services chapter).

SEM, in many circumstances, can be more profitable than BAU:

For example, 90% of agroforestry systems studied in Central America resulted in higher returns compared to traditional cultivation; similarly, better soil management practices in Southern Brazil resulted in higher incomes for farmers. In India, SEM sugar costs 15% less to produce. Businesses practicing SEM can reduce their operational costs (e.g., fertilizer, pesticides, equipment, labor) while society can gain by the reduction in external costs. For example, improved on-farm management in Brazil lowered off-site water treatment costs, while soil conservation in Costa Rica has significantly reduced costs of sedimentation of reservoirs (cf. Birris case study). Maximizing co-benefits by combining revenue streams from many sources is an option available in SEM: income from main products, secondary products, PES, REDD+, use values from subsistence products, and others.

SEM CAN PREVENT LOSS OF PRODUCTIVITY AND MITIGATE IMPACTS OF NATURAL PHENOMENA

Vulnerability to climate change of BAU and SEM scenarios: Climate change introduces uncertainty into the economic projections of the agriculture sector, which is highly vulnerable to climate variability. The implicit risk is reduced through the adoption of sustainable practices. Generally, SEM aligns with

climate change mitigation and adaptation, raising pliability and adaptability at the system level. SEM supports climate change adaptation through measures that include maintenance of crop and farming system diversity, use of drought-tolerant varieties, water harvesting and conservation, extensive planting, mixed cropping, agroforestry, low-input weed and pest control, and harvest of wild products. For example, farmers in Honduras consider a major benefit of the soil management technique known as Quesungual to be a greater resilience to floods (crops under the system showed no major damage after Hurricane Mitch).

Such considerations are important for the region in light of the expected worsening of storm events under climate change, and the severe impact of recent storms and flooding, as when Hurricane Mitch in 1998 wiped out 70% of crops in Honduras and many in other countries. Similarly extreme events on a smaller scale have occurred almost yearly in Central America, as in 2010 when Tropical Storm Agatha destroyed agricultural lands with damage estimated at \$19 million in Guatemala (ruining many crops in El Salvador and Honduras too).

SEM activities tend to be labor intensive, and thus can create jobs, helping avoid the rural exodus. Smallholder farming tends to be more labor intensive than extensive monoculture. Agro-forestry, organic farming and conservation tillage absorb more labor than traditional approaches.

Within SEM there are new and growing business opportunities: Changes in consumer preferences and other market forces can change the relative profitability of BAU and SEM practices. This is seen in the growing markets for organic and environmentally certified products from LAC. For example, growers have been able to increase profits by producing organic coffee in Mexico, Brazil, Nicaragua, the Dominican Republic, and Guatemala. Beef certification in Brazil has improved market access. Generally, fair trade certification implies not only better prices but also reduced market risk due to less price variability and improved market access via cooperatives. In addition, producers are generally less at risk with low-input systems in the event of rising prices of purchased inputs. Evidence from Costa Rica suggests that organic coffee plantations and those incorporating leguminous trees better sustain productivity in the face of decreasing fertilizer use.

SEM can help a country's competitiveness within global trade: Agricultural exports are vital to the region, at 44% of overall export value. This export revenue is fundamentally supported by practices that sustain productivity. In addition environmental management is becoming a requirement international buyers; international trade regulations are becoming more stringent (e.g., EU trade directives). *BAU's negative environmental reputation* in certain sectors (e.g., soy, cattle) has constrained sales and exports, adversely affecting individual companies as well as entire industries. Conversely, good environmental management can raise the competitiveness of the region's products, increase employment, and potentially secure price premiums as with organic coffee and bananas.

SEM CAN BE MORE EQUITABLE

The poor can lose from BAU: BAU generally contributes little to poverty alleviation, either by equitable access to opportunity or by equitable distribution of returns. Benefits tend to be concentrated in the hands of a few, such as large landowners, cattle ranchers, and agro-industrial enterprises. Increases in local agricultural production are often on the subsistence level, barely benefiting local communities or alleviating poverty within them, nor creating a better future for smallholders. The poor are often more exposed and vulnerable to air and water pollution occurring in *BAU* and less able to afford medical care. For example, in Ecuador, agricultural workers affected by pesticide poisoning were poor; treatment costs far exceeded their earnings.

SEM often benefits the poor and middle class: Agriculture can help reduce poverty if smallholders, individually or cooperatively, become suppliers to modern food markets, good jobs are created in agriculture and agro-industry, fair trade policies are pursued, and PES schemes are introduced. The smallholder orientation of many agroforestry, soil conservation, and other SEM approaches, and their frequent links to producer/community organization and empowerment: these factors support stabilization and economic improvement of rural populations.

Since the rural poor are, typically, more directly exposed to environmental degradation, these communities are positioned to be beneficiaries of SEM. Under appropriate market and institutional arrangements, SEM agriculture offers important socio-economic benefits to poor farmers, by improving net income, enhancing food security, and decreasing dependence on agrochemical purchases. Agroforestry can also bring benefits via reduced dependence on external sources of materials (e.g., fuelwood). Maximizing co-benefits to include varied income sources is a SEM strategy, especially for smallholders.

SEM also reduces household vulnerability to shocks, both economic and environmental. During extreme events, low-income households with minimal savings rely heavily on local natural resources, which tend to be more stable and abundant in SEM. For example, silvopastoral systems reduce dependency on chemical fertilizers and pesticides, save water for irrigation, protect soils and enhance fertility, and provide potential for additional incomes from harvesting fruit, fuelwood, and timber. Pérez (2004) found that Brazilian households with greater agricultural diversity had higher and less variable agricultural incomes, suggesting that incomes become more stable at higher levels of agricultural diversity.

TRANSITIONING FROM BAU TO SEM CAN BE AFFORDABLE, BUT DIFFICULT

BAU can reach a point at which the approach is not profitable but maintained out of tradition or lack of funding to cover the costs of transition to more appropriate technologies. Seed funding can catalyze the transition from BAU to SEM. An important constraint to adoption of silvopastoral practices is their high start-up costs and the low benefit level in the

early years while the trees are growing. As a result, policies to bridge the investment cost of silvopastoral systems and/or payments for the additional ES generated by this management system may be required to foster adoption. Barriers to adoption, especially by smallholders, can be removed by addressing lack of technical assistance, credit constraints, and unfavorable land tenure conditions (Pagiola et al. 2007). The policy environment can also be a key enabler in decisions over alternative agricultural practices. By disallowing externalities and removing perverse incentives (e.g., subsidies on fertilizer and for BAU cattle ranching) SEM gains relative to BAU, while policies that support PES can reward landowners for maintaining otherwise un-priced ES. Pilot PES projects focused on the restoration of degraded pastures to silvopastoral systems are underway in Columbia, Costa Rica, and Nicaragua. While such schemes need careful design with clear understanding of the service being provided and evidence of demand, agricultural PES in LAC are expected to grow.

Recommendations

The agriculture sector is fundamentally dependent on ES. Sustainable management of these natural services is, thus, central to the future of the sector. There are a number of existing and developing drivers that support uptake of SEM. These drivers include general trends in public awareness, consumer tastes, and international standards moving in a direction favorable to SEM, the increasing scarcity of ES coupled with a growing understanding of their economic importance, technological advances to increase the efficiency of SEM practices, and the compatibility of many SEM practices with climate change mitigation and adaptation objectives. However, it is equally clear that broad scale uptake of SEM will require policy changes to remove distortions and to lower barriers to switching to sustainable management. Furthermore, such policies need to be supported by better data-based evidence of the economic costs and benefits of SEM.

Key Economic Policy Recommendations to Promote the Uptake of SEM Are:

- Remove perverse incentives
- Create positive incentives
- Promote integrated natural resource management across Ministries
- Support businesses to adopt SEM
- Promote social cost-benefit analysis of alternative management practices
- Develop data bases

Market-based policies need to be supported by regulation. This includes enforcing existing regulations that level the playing field between BAU and SEM, thus freeing the SEM approach to compete. On a larger scale, the switch from BAU to SEM will call for broader planning and regulatory initiatives.

REMOVE PERVERSE INCENTIVES

A first step for governments is to review and reform policies that promote BAU activities by making them artificially more profitable than SEM. Key to this reform is the removal of damaging subsidies for agricultural fuel, irrigation and agrochemicals, or land tenure policies that allow cheap acquisition of lands if they are deforested. Such subsidies make it possible for BAU to compete with SEM much longer than otherwise would be possible. This will deform the decision making process and typically result in sub-optimal economic decisions. These subsidies have caused overuse and damage of ES resulting in long term cost to the sector.

CREATE POSITIVE INCENTIVES

Damaging subsidies should be replaced by well structured ones that benefit the environment, such as subsidies to defray the costs of organic certification or for credit to facilitate SEM system set-up expense, and well structured and monitored PES. A switch from perverse to sound subsidies could be income neutral. Such an approach was adopted under Europe's reformed Common Agricultural Policy, where payments to farmers were maintained at the same total, yet were no longer linked to the volume of production but to a series of environmental, food safety, and animal welfare standards as well as the requirement to keep farmland in good agricultural and environmental condition.

An alternative is to introduce tax breaks for SEM practices, for example on the import and manufacture of SEM technologies such as solar energy for agriculture, or on the export of SEM products to increase their international competitiveness.

Low on-farm profitability hinders adoption of socially-beneficial practices. Profits from sustainable management of ES at the farm gate can also be maximized via incentives based on social benefits of conservation initiatives, for example, PES and promotion of co-benefits from sustainable management

PROMOTE INTEGRATED NATURAL RESOURCE MANAGEMENT

Agriculture Ministries are not solely responsible for managing the full range of ES on which their sector depends. Many of the key ES provided to agriculture originate, in part, outside of the farm gate. For example, water quantity and quality depends on the management of upstream lands, which may be under the jurisdiction of a range of institutions, while pollination services may be dependent on the management of off-site forest land. This means that the way landscapes surrounding the farm (e.g., watersheds and forests) are managed will affect agricultural productivity. Optimal management of ES important to agriculture, therefore, requires a coordinated response across line Ministries with a stake in the ES. The Ministry of Agriculture needs to first

identify and understand the role of these services and their competing uses and related pressures, and then to work with other Ministries to find appropriate policies to maintain and use these services to the long-term benefit of the country, accounting for the economic and social tradeoffs. The knowledge, skills, and organization required to implement this approach will have to be nurtured by successive administrations. This will require multi sectoral co-ordination, involvement of stakeholders, and broad political consensus.

Under the polluter-pays principle, where costs are being imposed on agriculture by activities off site, the actor responsible is required to account for these costs. By charging for the off-site degradation of ES, the profitability of the polluter is reduced and the activity made less financially attractive. Alternatively, upstream users can be paid to maintain ES (e.g., the development of PES for pollination).

FACILITATE THE TRANSITION TO SEM BY BUSINESSES

Governments should consider options to catalyze interest in SEM both for enterprises based on the BAU model and new start-ups deciding between BAU and SEM. This encouragement is needed both at the smallholder and agri-business scales.

There are a number of barriers that hinder the uptake of SEM. For example, practices such as agroforestry have high start-up costs and delayed earnings on investment. Such barriers can be overcome through the provision of credit or other sources of finance and training to support the cost of adoption, change, and technology uptake. A lack of information, technical know-how, and access to markets also restrict SEM adoption (i.e., related to soil management practices and organic production) and can be overcome through dissemination campaigns, technical support programs, and support to get SEM products marketed. Certification is a key market-based tool in the agriculture sector for capturing the economic value of certain ES, which already has a good track record in the region that can be built further built on.

The trend toward larger agribusiness and buyers (supermarkets) presents barriers to smallholders and equity concerns. It is recommended that governments work with the food industry to develop policies to source products for sustainable outlets, including smallholder production to address poverty and promote equity. Organization of a regional workshop to establish a network of SEM “big” buyers would provide

a welcome forum and follow-up mechanism to generate and implant strategies to catalyze SEM.

PROMOTE SOCIAL COST-BENEFIT ANALYSIS OF ALTERNATIVE MANAGEMENT PRACTICES

The number of cases where alternative agricultural management options have been fully evaluated is extremely limited. The promotion of social CBA by public sector and other stakeholders would allow a more rounded balancing of options and, hence, improved decision making. This analysis could factor in externalities and take on board a two to three decade time frame. Adoption of such a default framework for decision makers would discourage financial options focused on short-term profits for private individuals and encourage options that are in society’s interest: viable over the long term.

DEVELOP DATA BASES

Good data, both economic and physical, underpins sound economic assessments and the formulation of economic instruments and policies. There are data gaps in regard to the costs and benefits of BAU and SEM. Filling these gaps will strengthen the evidence available to help design policies that encourage optimal agricultural practices. For example, large robust data bases would allow assessment of the opportunities of SEM, measurement of the costs of BAU (and their distribution across social groups), and identification of situations where SEM is already preferable to BAU but change is delayed due to inertia or private interests.

In order to improve data on costs and benefits, stakeholders – especially public agencies – should generate and publish business and economic data on a regular, systematic basis. This should be done by assuring operation of proper business data registries, quantifying environmental impacts, developing models to capture externalities, and commissioning studies to fill key data gaps. Capabilities of the Ministries of Agriculture to determine and value the loss of soil fertility should be strengthened, for instance; and national accounts for ES should be developed so the corresponding agencies can register country investments and gaps in funding ES maintenance. Finally, information technology and communication strategies to promote SEM products and services to the market, the business community, and civil society should also be developed.

TABLE 1. AGRICULTURE AREA IN LATIN AMERICA AND THE CARIBBEAN¹ (1990-2007)
(AREA IN 1,000 HA)

REGION/COUNTRY	AGRICULTURE				
	1990		2007		% CHANGE
	AREA	%	AREA	%	
SOUTH AMERICA					
ARGENTINA	127,390	45.8	131,350	47.2	3.1
BOLIVIA	35,455	32.3	36,828	33.5	3.9
BRAZIL	241,608	28.4	263,500	30.9	9.1
CHILE	15,899	21.0	15,762	20.8	-0.9
COLOMBIA	45,083	39.5	42,436	37.2	-5.9
ECUADOR	7,846	27.7	7,412	26.1	-5.5
PARAGUAY	17,159	42.2	20,400	50.2	18.9
PERU	21,836	17.0	21,560	16.8	-1.3
URUGUAY	14,825	84.1	14,683	83.3	-1.0
VENEZUELA	21,860	24.0	21,350	23.4	-2.3
FALKLAND ISLANDS	1,190	97.8	1,118	91.9	-6.1
CENTRAL AMERICA & MEXICO					
BELIZE	126	5.5	112	4.9	-11.1
COSTA RICA	2,760	54.0	2,750	53.8	-0.4
EL SALVADOR	1,410	67.0	1,556	74.0	10.4
GUATEMALA	4,285	39.4	4,464	41.0	4.2
HONDURAS	3,320	29.6	3,128	27.9	-5.8
MEXICO	103,800	52.8	106,800	54.4	2.9
NICARAGUA	4,025	30.9	5,200	39.9	29.2
PANAMA	2,124	28.2	2,230	29.6	5.0
THE CARIBBEAN					
ANGUILLA	-	-	-	-	-
ANTIGUA AND BARBUDA	13	29.5	13	29.5	0.0
ARUBA	2	11.1	2	11.1	0.0
BRITISH VIRGIN ISLANDS	9	60.0	8	53.3	-11.1
CAYMAN ISLANDS	3	11.5	3	11.5	0.0
DOMINICA	18	24.0	23	30.7	27.8
DOMINICAN REPUBLIC	2,550	52.4	2,517	51.7	-1.3
FRENCH GUIANA	21	0.2	23	0.3	9.5
GRENADA	13	38.2	13	38.2	0.0
GUADELOUPE	53	45.3	44	37.6	-17.0
GUYANA	1,732	8.1	1,680	7.8	-3.0
HAITI	1,597	57.5	1,690	60.9	5.8
JAMAICA	476	43.3	513	46.7	7.8
MARTINIQUE	39	35.5	28	25.5	-28.2
MONTSERRAT	3	30.0	3	30.0	0.0
NETHERLANDS ANTILLES	8	10.0	8	10.0	0.0
PUERTO RICO	435	48.6	189	21.2	-56.6
SAINT KITTS AND NEVIS	12	46.2	5	19.2	-58.3
SAINT LUCIA	21	33.9	11	17.7	-47.6
SAINT VINCENT & GRENADINES	12	30.8	14	35.9	16.7
SURINAME	88	0.5	83	0.5	-5.7
TRINIDAD AND TOBAGO	77	15.0	54	10.5	-29.9
TURKS AND CAICOS ISLANDS	1	1.1	1	1.1	0.0
US VIRGIN ISLANDS	11	31.4	4	11.4	-63.6

Source: Based on FAO statistics

1. Data for Brazil, Chile, Costa Rica, Dominican Republic, Ecuador, Honduras, Panama, Peru and Venezuela are for 2006; data for Colombia and Paraguay are for 2005; statistics for Bolivia and El Salvador correspond to 2004; and for Guatemala and Nicaragua are for 2002 and 2001 respectively.

TABLE 2. OVERVIEW OF AGRICULTURE POPULATION AND POVERTY IN LAC

	RURAL POPULATION			AGRICULTURE POPULATION			ACTIVE POPULATION IN AGRICULTURE			% POVERTY		
	QUANTITY	%	QUANTITY	%	QUANTITY	%	QUANTITY	%	QUANTITY	%	TOTAL	RURAL
	1990	2009	1990	2009	1990	2009	1990	2009	1990	2009	Year(t)	
SOUTH AMERICA	1990	2009	1990	2009	1990	2009	1990	2009	1990	2009		
ARGENTINA	4,230	3,137	4,097	3,165	13	8	1,454	1,424	4	4		
BOLIVIA	2,963	3,345	3,046	3,966	44	34	1,193	1,950	18	20	63.9	80.6
BRAZIL	37,683	26,890	34,989	21,763	25	14	14,056	11,367	9	6	33.3	50.10
CHILE	2,207	1,909	2,480	2,299	17	11	935	968	7	6	13.70	12.30
COLOMBIA	10,534	11,519	8,870	7,068	32	25	3,343	3,547	10	8	46.80	50.50
ECUADOR	4,616	4,590	3,503	2,773	45	34	1,119	1,176	11	9	43.00	49.00
PARAGUAY	2,180	2,482	1,724	1,924	51	39	577	821	14	13	60.50	68.10
PERU	6,772	8,309	7,225	7,104	31	28	2,785	3,723	13	13	44.50	69.30
URUGUAY	343	254	389	338	11	8	185	187	6	6	N/A	N/A
VENEZUELA	3,102	1,785	2,877	1,843	16	6	870	735	4	3	30.20	N/A
AVERAGE	7,463	6,422	6,920	5,224.3	29	21	2,651.7	2,589.8	10	9		
CENTRAL AMERICA & MEXICO	1990	2009	1990	2009	1990	2009	1990	2009	1990	2009		
BELIZE	100	147	64	75	53	48	19	31	10	10	N/A	N/A
COSTA RICA	1,518	1,657	821	744	49	36	308	323	10	7	19.00	20.40
EL SALVADOR	2,706	2,405	1,929	1,640	51	39	655	593	12	10	47.50	56.80
GUATEMALA	5,247	7,156	4,998	5,973	59	51	1,487	2,023	17	14	60.20	68.00
HONDURAS	2,928	3,856	2,165	2,038	60	52	674	669	14	9	71.50	81.50
MEXICO	23,838	24,630	25,287	20,227	29	22	8,344	7,821	10	7	31.70	40.10
NICARAGUA	1,972	2,468	1,224	921	48	43	392	358	9	6	69.30	77.00
PANAMA	1,113	895	725	632	46	26	247	250	10	7	30.80	46.60
AVERAGE	4,927.8	5,401.8	4,651.6	4,031.3	49	38	1,515.8	1,508.5	12	9		
THE CARIBBEAN	1990	2009	1990	2009	1990	2009	1990	2009	1990	2009		
ANTIGUA AND BARBUDA	40	61	17	18	65	69	7	8	11	9	N/A	N/A
THE BAHAMAS	52	55	13	9	20	16	6	5	2	1	N/A	N/A
BARBADOS	175	153	17	7	67	60	9	4	3	2	N/A	N/A
DOMINICA	22	17	19	14	32	25	7	6	10	9	N/A	N/A
DOMINICAN REPUBLIC	3,301	3,050	1,978	1,170	45	30	637	481	9	5	44.50	49.50
GRENADA	65	72	27	22	68	69	10	9	10	9	N/A	N/A
GUYANA	528	546	161	115	70	72	59	52	8	7	N/A	N/A

	RURAL POPULATION			AGRICULTURE POPULATION			ACTIVE POPULATION IN AGRICULTURE			% POVERTY				
	QUANTITY	%	QUANTITY	%	QUANTITY	%	QUANTITY	%	QUANTITY	%	TOTAL	RURAL		
HAITI	5,081	5,190	71	52	4,865	5,947	68	59	1,783	2,287	25	23	N/A	N/A
JAMAICA	1,195	1,265	51	47	584	485	25	18	275	216	12	8	N/A	N/A
SAINT KITTS AND NEVIS	27	35	66	67	11	11	27	21	4	5	10	10	N/A	N/A
SAINT LUCIA	98	124	71	72	38	35	28	20	15	17	11	10	N/A	N/A
SAINT VINCENT AND THE GRENADINES	64	57	60	52	30	23	28	21	12	11	11	10	N/A	N/A
SURINAME	129	128	32	25	85	88	21	17	29	33	7	6	N/A	N/A
TRINIDAD AND TOBAGO	1,115	1,158	91	86	134	90	11	7	50	48	4	4	N/A	N/A
AVERAGE	849	851	58	53	570	574	25	18	207	227	10	8		

Source: www.fao.org and IICA (2008).

CHAPTER 7.

FISHERIES SECTOR

Charlotte Boyd

This report seeks to highlight the economic contribution of biodiversity conservation and ecosystem services to development and equity in the Latin American and Caribbean region, hence, making an economic case for mainstreaming biodiversity and ecosystem conservation into national policies and development strategies.

7.1 INTRODUCTION AND OBJECTIVES

The fisheries sector is economically important in Latin America and the Caribbean (LAC), contributing to food security, employment, domestic income, foreign exchange earnings, and fiscal revenues. Fisheries are especially important to the livelihoods of the poor in coastal regions or near inland waters in LAC.

Fisheries depend, in turn, on the natural services provided by ecosystems, from provisioning of habitats critical to each life stage of targeted species and the food chains that sustain them, to regulation of ambient conditions and maintenance of essential metabolic, growth, and reproduction processes. Degradation or loss of such ecosystem services contributes to fisheries depletion or collapse, especially under pressure of overfishing.

The pattern of marine fisheries development in LAC parallels that in the rest of the world. Marine capture fisheries production has probably reached a plateau, despite increases in fishing capacity (FAO 2008). Further development is, thus, likely to be achieved through rebuilding depleted fisheries, restoring essential habitats, and increasing economic efficiency (Hilborn et al. 2003; Worm et al. 2009; World Bank 2009).

Recognizing this, several countries in LAC have started to reorient their fisheries toward sustainable ecosystem management (SEM). The goal of SEM in fisheries is to generate optimal sustainable yields, while safeguarding the capability of ecosystems and biodi-

versity to provide the ecosystem services (ES) upon which fisheries and other economic activities depend. The SEM approach involves investing in natural capital for fisheries, by maintaining or restoring the productivity, structure, and function of aquatic ecosystems. Maximizing economic rather than biological yields in fisheries will generally require larger stock biomass, meaning that economic and ecological objectives often point in the same direction (Grafton et al. 2006).

In many fisheries around the world, responsible management has succeeded in reducing excessive exploitation, in rebuilding depleted fisheries, and in sustaining those that contribute to national economies (Worm et al. 2009). There is growing consensus about the policy frameworks and management tools required, especially for high-value industrial fisheries. Several countries in LAC are at the forefront of developing and adapting these tools and approaches. A major challenge in the region is that many economically-important fisheries are characterized by large numbers of small vessels targeting multiple species. The tools that have been developed for industrial fisheries management are less well-suited to these small-scale fisheries. Several countries in LAC are pioneering new approaches and tools for managing them.

The goal of this chapter is to foster further progress towards SEM by providing policy makers with information on the economic value of taking an ecosystem approach to fisheries management. Case studies are used to highlight the economic costs of Business as Usual (BAU), the potential net benefits of moving toward SEM, and key policies and strategies for transition. In doing so, the focus will be on marine-capture fisheries as opposed to freshwater ones and aquaculture systems, which also offer many examples.

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The BAU approach in fisheries refers to management strategies that maximize short-run returns without considering external or long-run costs. Research shows that BAU practices deplete fish stocks and degrade essential fish habitat and other key ES, leading to loss of economic value. This situation undermines the long-term, ecosystem-wide economic potential of fisheries and related resources. In addition, BAU has direct costs, in terms of lost yields, and indirect costs associated with fishing overcapacity, subsidies, and illegal or unregulated (IUU) fishing. Furthermore, BAU does not take into account external impacts on broader ecosystem function and services, nor on other economic and non-economic activities and values (like coral reef-based tourism and social norms on biodiversity preservation).

Key Findings

The chapter examines the contribution of responsible fisheries management to key facets of development:

- **Depleted fisheries can be rebuilt under SEM** (usually); production is higher following rebuilding and the risks of collapse are lower than during the overfishing that led to depletion.
- **Returns on investment** are expected to rise as SEM maximizes economic yields and reduces fisheries overcapacity and over-investment, avoiding unbridled, self-defeating competition under BAU.
- **Employment** may rise or fall under SEM depending on the situation. Fisheries with overcapacity may see an interim reduction followed by restructuring in favor of fewer but more permanent, stable jobs.
- **Fiscal impacts** will depend on measures to recover fisheries management costs and to capture part of the increases in economic rent.
- **Equity** will be served by stakeholder engagement at all levels, more transparent decision-making, and, in some cases, by co-management of common property resources — all enhancing sustainability of ES.

Where possible, this chapter develops comparative scenarios of the future of specific fisheries under BAU versus SEM. The text highlights a series of steps to develop the policy framework and sustainable management strategies that can support further transition toward SEM in LAC fisheries, maximizing the economic value of marine ES in the fisheries sector.

Specific observations include the following:

- The role of fisheries in LAC and their economic relevance is substantial: contributions to GDP, exports, employment, food security, fiscal revenues, and social safety nets. In 2004, four countries derived more than \$2 billion annually from fisheries, and five more over \$100 million, playing a part in industrial development as well as in the livelihoods of many impoverished communities.
 - Maintenance of the ecological services and habitats that allow targeted stocks to thrive, along with the ecosystems that support them, is a critical consideration in fisheries governance.
 - A number of countries have begun to reorient their fisheries toward SEM to improve and sustain yields while safeguarding the capability of ecosystems to provide the services upon which fisheries and other economic activities depend.
 - Responsible management of single species and multi-species fisheries is integral to SEM. SEM builds on the FAO Code of Conduct for Responsible Fisheries and the Ecosystem Approach to Fisheries, widely accepted as the appropriate framework to manage marine-capture fisheries. This can include temporary or spatial refugia.
 - Fisheries managers and authorities can compare current versus potential sustainable economic rent for fisheries to identify promising candidates for transition to SEM.
 - Maximizing economic yields and reducing risks in fisheries generally requires larger stock biomass than maximizing biological yields. Economic and ecological goals both point in the same direction.
 - A major challenge is that many fisheries are composed of large numbers of small vessels targeting multiple species. Some tools that have been developed for industrial fisheries management are less well-suited to small-scale fisheries. Several countries in LAC are pioneering alternative approaches and have developed innovative and effective tools for managing small-scale fisheries.
 - When access to fisheries resources is insecure, fishers have strong incentives to maximize short-term profits, often leading to overfishing, development of overcapacity, and a ‘race to fish’ — both economically wasteful and destructive of ecological services. Catch shares, territorial use rights and related management systems are designed to provide actors with greater security over resource access and, hence, incentives to invest in maintaining or restoring stocks.
- The LAC region is home to a wide variety of catch share systems, with examples in Argentina, Chile, Mexico, and Peru among others. These approaches often require legislative

change but result in sustainable benefits: increased catches, improved economic performance, and steady livelihoods for fisher populations and coastal communities.

Sonora (FAO n.d.; FAO 1996). Most of these contributions to GDP have been made under BAU management practices.

7.2 CONTRIBUTION OF FISHERIES TO NATIONAL ECONOMIES IN LAC

Fisheries are a vital part of the natural resources sector in LAC, contributing to gross domestic product (GDP), employment, food security, and the livelihoods of the poor. LAC is one of the world's most important fishery regions, with Peru the second largest fish producer in the world, and Chile also regularly in the top ten. Brazil features in the top ten inland capture fisheries (FAO 2008).

Gross Domestic Product (GDP)

In 2004, fisheries in Chile, Mexico, Colombia, and Brazil contributed more than \$2 billion to GDP, and in Venezuela, Panama, Argentina, Guyana, and Peru, more than \$100 million (Catarci 2004; Tietze et al. 2006; FAO 2008; World Bank 2008). The relative importance of fisheries to national economies is reflected in their contribution of 1% or more of GDP in 11 of the 25 LAC countries for which data are available (Figure 7.1, Appendix 7.3). Fisheries contribute 6.3% of GDP in Ecuador, 5.0% in Belize, 3.9% in Colombia, 3.2% in Chile, and 2.0% or more in the Bahamas, Grenada, Guyana, Panama, Peru, and St. Vincent and the Grenadines. National statistics may conceal the contribution of fisheries at a sub-national level. For example, fisheries account for 0.8% of Mexico's GDP, but 2.3% of GDP in the state of

Structure of the Fisheries Sector in LAC

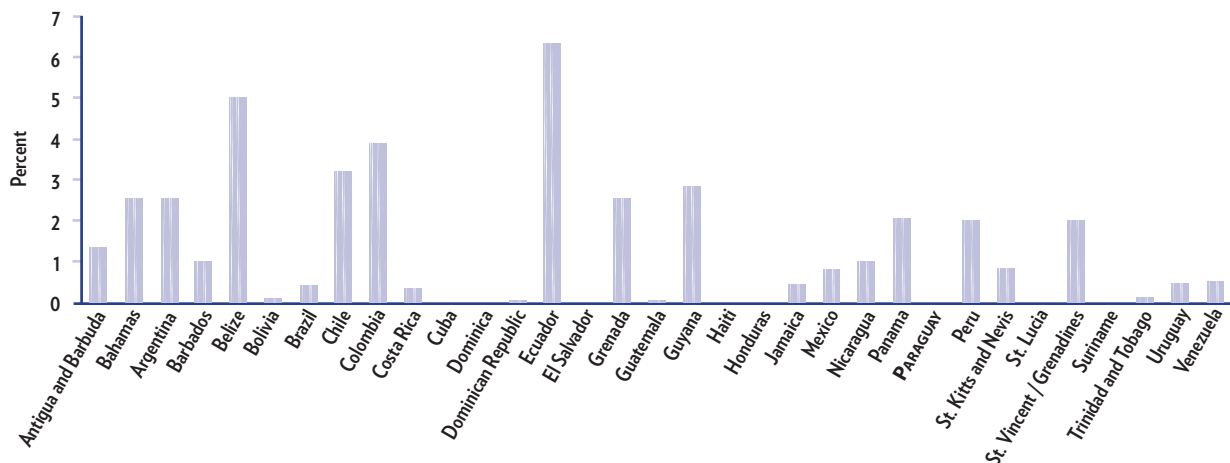
Fisheries production in LAC is dominated by marine pelagic capture fisheries: anchovy, sardines, and other schooling fish. These species provided 85% of regional production by volume in 2004 (Figure 7.2), primarily as raw material for the production of fish meal and oil (FAO 2004). However, lower volume fisheries may have higher values, as is reflected in Figure 7.3.

Demersal, pelagic, and shrimp fisheries each contribute one fifth or more of total value, followed by lobster and crab, benthopelagic, and cephalopod fisheries (Figure 1.2.3). This pattern varies by country. Pelagics are the most important contributor by value in Peru and Chile; benthopelagics in Argentina; demersals in Uruguay and Brazil; demersals and shrimps in Guyana, Venezuela, and Colombia; shrimps in Mexico, Guatemala, Honduras, and Costa Rica; lobster and crabs in Cuba, the Bahamas, and Nicaragua; and reef fish in Grenada, and St Kitts and Nevis (SAUP Database). The different fisheries present distinct challenges from both an ecological and management perspective (Table 7.1).

Foreign Exchange Earnings

Fisheries are major generators of exports in some LAC countries. In 2007, fisheries products contributed more than \$3 billion to exports in Chile and more than \$1 billion in Argentina, Ecuador, and Peru (FAO 2008). The share contributed by fisheries to total merchandise exports highlights their importance to a range of countries. In

Figure 7.1. Percentage Contribution of Fisheries Sector to GDP



Source: Fishery and Aquaculture Country Profiles <http://www.fao.org/fishery/countryprofiles/search/en> [multiple years]

Figure 7.2 Catches by LAC Fleet in Their Own EEZs *by Volume (tons)

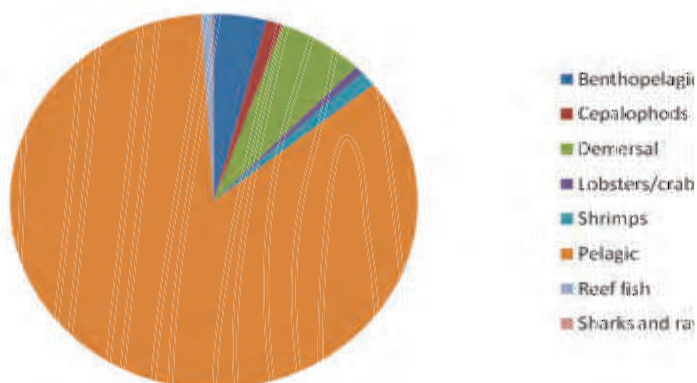
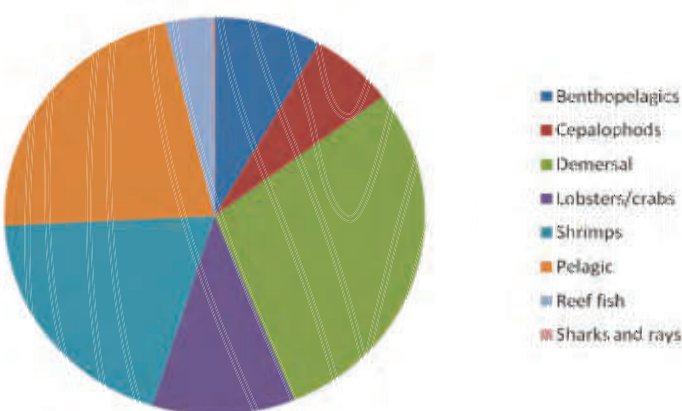


Figure 7.3 Catches by LAC Fleet in Their Own EEZs *by Value (\$ of 2000)



2006, fisheries contributed 33% of merchandise exports in Panama and between 10% and 16% in the Bahamas, Belize, Ecuador, Grenada, Guyana, and Nicaragua (Figure 7.4).

Employment

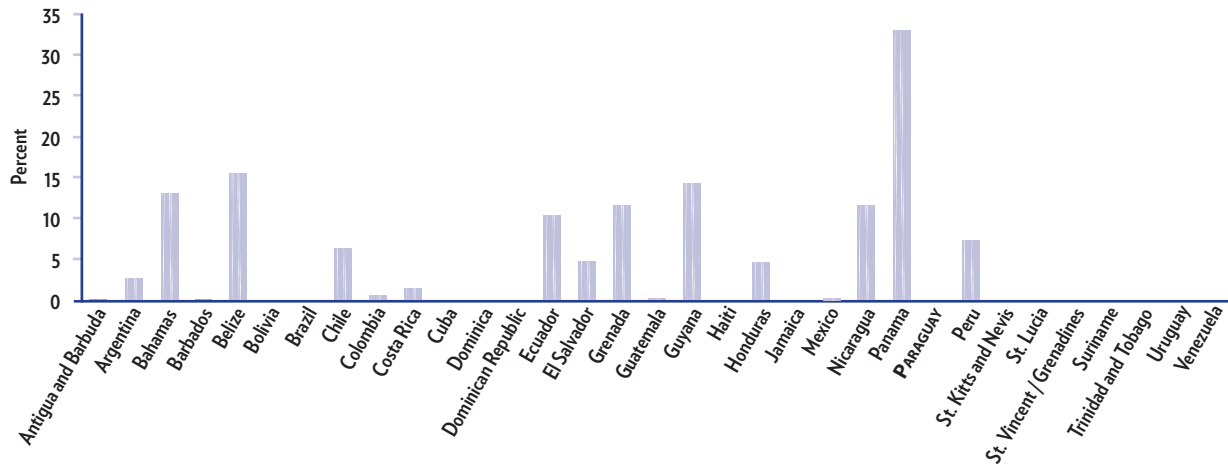
Across the region, fisheries provide about 1% of total employment; they employ more than 5% in Dominica, Suriname, St Vincent and

the Grenadines, Brazil, the Bahamas, and Guyana (Figure 7.5). In 2008, this represented over 1.64 millions jobs directly in the sector and an additional 731,000 in associated secondary employment (table and sources in Appendix 7.4). More than 1 million are employed in fisheries in Brazil, and over 100,000 in each of the fisheries of Mexico, Chile, Peru, Ecuador, and Argentina. Total employment may be underestimated, given evidence that for each fisher, three persons are employed in processing, marketing, or distribution (Macfadyen and Corcoran 2002 cited in Reid et al. 2005). Nor is

TABLE 7.1. CHALLENGES TO DIFFERENT TYPES OF FISHERIES

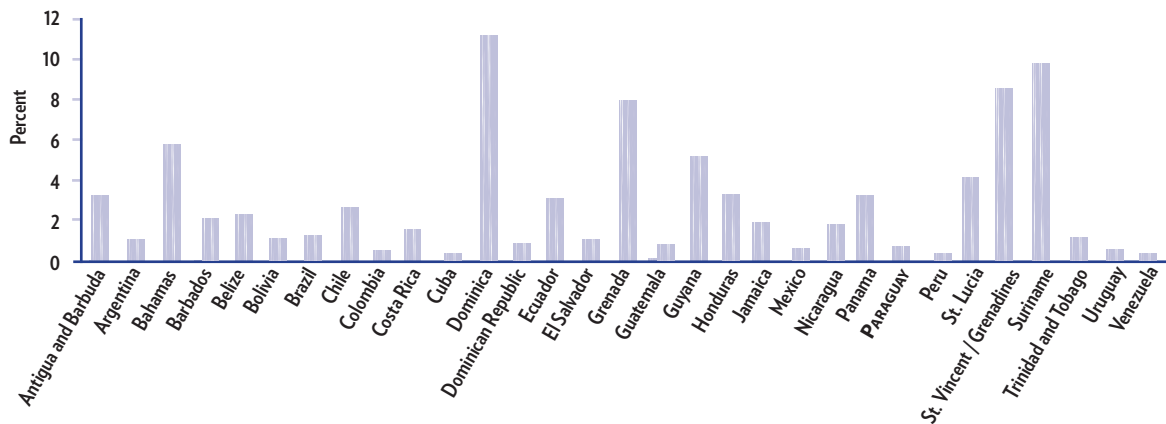
FISHERY RESOURCE	MAJOR CONCERNS
Demersals (e.g., hake, grouper) [= bottom dwellers]	Threats to spawning and recruitment through overfishing Degradation of habitat and ecological services, especially in reef fisheries
Pelagics (anchoveta, sardinella, jack mackerel) [= swimmers in the water column]	Threats to recruitment through overfishing
Benthopelagics (Chilean seabass) [= deep swimmers] Shrimp (crustaceans)	Often slow-growing and long-lived so vulnerable to overfishing Loss of essential nursery habitat and ES; impacts of by-catch/discards on other fisheries and impacts of trawling on essential fish habitat
Lobster and crab (crustaceans) Cephalopods (squid, octopus)	Threats from loss of nursery habitat; overfishing Threats from destruction of spawning habitat and structures, especially for restricted range species

Figure 7.4 Fishery Exports as a Percent of Total Merchandise Exports (2006)



Source: FAO 2007?

Figure 7.5 Employment in Fisheries Sector as a Percent of Total Employment



it clear how the 2.4 millions jobs listed are split between industrial and small-scale fisheries. A separate, perhaps overlapping source estimates over a million employed in the small-scale sector (Appendix 7.4). The informal economy may also have additional fisheries jobs, especially part-time or seasonal, not reflected in those figures. Clearly, many more people are engaged in fishing in the region than there are formal fisheries jobs.

Employment. Small-scale fisheries tend to be labor intensive (FAO 2005). In a study of Pacific marine capture fisheries, FAO (2007) found that small-scale fisheries involved 2.5 times more participants per unit of product than large-scale fisheries. In the 22 LAC countries with data available, there are approximately 1.035 M small-scale fishers (Chuenpagdee et al. 2006). Many of these fishers work in fisheries on a part-time or temporary basis to supplement other food and income sources. Fishing as a secondary or complementary activity, including seasonal fishing, is essential to many rural and coastal households (FAO 2005). These opportunities are particu-

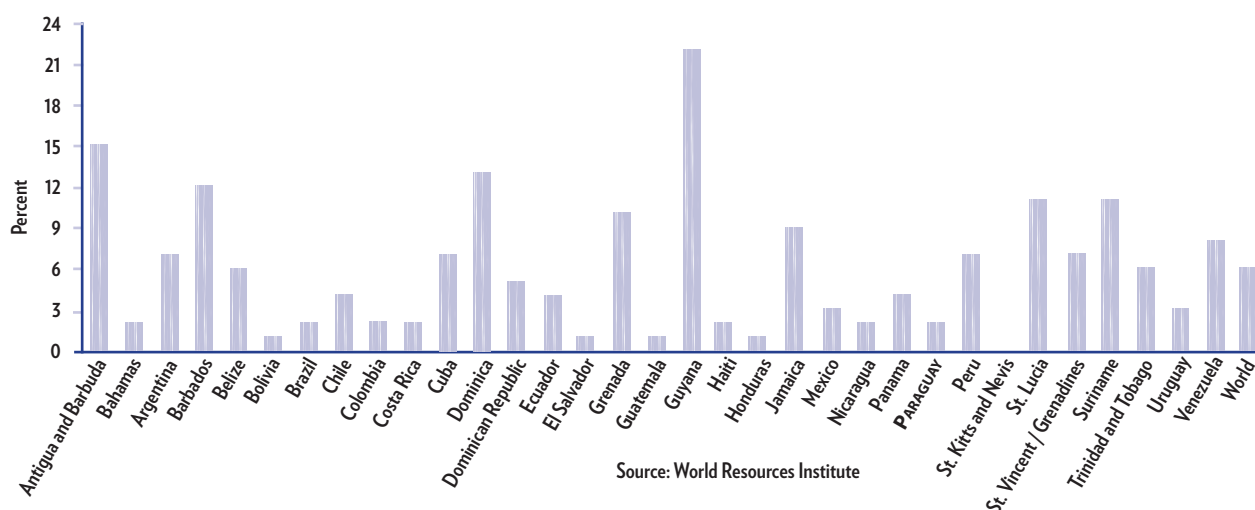
larly important if they are a main source of food or cash to households, or if they come in periods of low labor demand for other activities such as agriculture.

Food Supply

Fisheries provide an important contribution to food supply at the national level. In 13 of 33 LAC countries for which data is available, the percentage of protein supply from fish products equals or exceeds the world average of 6% (Figure 7.6). Global population growth and corresponding increases in demand for food suggests that the need to build food security may be expected to continue (FAO 2005).

Food Security. Worldwide, fish can exceed 25% of the total animal protein used in the poorest countries, reaching as much as 90% in isolated inland and coastal areas. Fish is particularly valu-

Figure 7.6 Fish Protein as a Percentage of Total Protein Supply (2000)



able where other sources of animal protein are scarce or expensive (FAO 2005). Small-scale fisheries often supply local markets as well as support subsistence consumption (Thorpe et al. 2000). Poor households may sell much of their catch and use the cash to purchase cheaper foods. Increases in fish prices, attributable to rising demand, will benefit households that are net producers of fish, but will harm those that are net consumers.

Global increases in aquaculture production, though significant, have not offset the stagnation in total fish production (Liu and Sumaila 2008). Excluding China, population growth has outpaced the growth of total food fish supply, resulting in a decrease in per capita fish supply (FAO 2002). Stable or declining catches in the face of growing demand have led fish prices to rise dramatically in some local markets, placing an essential source of protein out of reach for many low income consumers (Ovetz 2006).

Fisheries as Factors in Poverty Alleviation

There have been growing efforts to understand poverty and vulnerability in fishing communities and the potential of fisheries to contribute to poverty alleviation. Research has focused on small-scale fisheries, with little data on poverty among industrial fishery workers. Small-scale fishers are vulnerable because of the unpredictable nature of fishing and because most of these fishers lack tenure over the resources they exploit. Many small-scale fishing communities are remote and isolated, with limited access to basic infrastructure, capital, and technology, and few economic alternatives (FAO 2005). Many small-scale fisheries in LAC are being degraded rapidly; concern about overfishing is widespread (Chapman et al. 2008). Small-scale fishing communities, traditionally reliant on near-shore marine resources, are affected by reduced access to

seafood for subsistence, underemployment, and income reduction (Defeo and Castilla 1999).

On the other hand, well managed small-scale fisheries can contribute to poverty reduction by generating prosperity at the household level or by acting as an engine for local economic growth (Thorpe 2005; FAO 2005). Small-scale fisheries can be economically efficient and generate jobs and profits. For example, the spiny lobster (*Panulirus argus*) fishery along the Yucatan Peninsula represents one of the world's most important artisanal fisheries (Defeo and Castilla 2005). Modernization, technological innovation, and export orientation have become features of many small-scale fisheries in recent years. In Chile, Argentina, Mexico, and Costa Rica, small-scale fishers directly export their products (FAO 2005).

Fisheries can be an important source of food security, employment, cash income, and improved equity for impoverished populations in coastal areas and near inland water bodies (FAO 2005).

Gender Equity. Fisheries jobs can employ women as well as men in both the harvesting and processing sectors (FAO 2005). In the state of Bahia, Brazil, approximately 20,000 women harvest shellfish for sale. Women represent 39% of labor employed in Chile's industrial fishing sector (Gallardo Fernández 2008).

Fisheries as a Safety Net. Small-scale fisheries, like other open access or common property resources, can provide an important safety net that may be critical to a large proportion of the poor in coastal and rural areas. In these cases, open access is the key factor that enables fisheries to fulfill this safety-net function (FAO 2005). This has implications for the design of systems to provide more secure tenure in small-scale fisheries. For many fishing communities, diversification of target species is an important risk management strategy for maintaining income and employment in the face of variable resource availability.

7.3 DEVELOPMENT AND CURRENT STATUS OF FISHERIES IN LAC

Development of fisheries in LAC Under BAU

World production from capture fisheries leveled off in the late 1980s, despite technological advances and increases in fishing effort (Hilborn et al. 2003; Gelchu and Pauly 2007). The data suggest that marine capture fisheries production has reached a maximum (FAO 2008). For marine capture fisheries, further development is most likely to be achieved through rebuilding depleted fisheries, investing in the natural capital on which productivity depends, and increasing the economic efficiency of fishery exploitation (Hilborn et al. 2003; Worm et al. 2009; World Bank 2009).

Available data on fisheries production in LAC are consistent with this global pattern. In LAC, fisheries development was lim-

ited until the post-war period, when increasing world demand for fish products stimulated investment in export-oriented fisheries in some places (Gelchu and Pauly 2007). Fisheries development was further advanced by the establishment of Exclusive Economic Zones (EEZs) in the 1970s, with substantial government investment and subsidies in many countries (Khan et al. 2006; Gelchu and Pauly 2007; Abdallah and Sumaila 2008). But this expansion led to the collapse or near-collapse of several fisheries, including the Peruvian anchoveta, Brazilian sardinella, and Argentinean hake, among other fisheries (Christy 1997). The volume of fisheries production in LAC expanded steadily through the 1980s, peaked in the 1990s, and has been stabilizing or declining thereafter (Figure 7.7) (Thorpe et al. 2000). The sector has been built largely under BAU conditions and practices. Since this led to collapse of a growing number of fisheries, a shift toward SEM approaches has occurred in some cases, usually focused narrowly on particular stocks. In other cases, adjustments were made within the BAU scenario, such as serially depleting species down the trophic chain.

Box 7.1. Fisheries sub-sectors in LAC

The fisheries sub-sectors of LAC economies are characterized by a diversity of scales of operation and modes of organization. Jopia and Yazigi (2009) describe the main sectors in Chile in terms that are broadly applicable to the entire region (to which recreational and sport fisheries have been added):

Industrial Fisheries. Purse-seine, trawl, long-line, or other harvesting operations that use boats and equipment that exceed a threshold size (e.g., for Chile, the industrial sector is characterized by the use of vessels with a hold capacity above 50 t and a length over 18 m). Large corporate fishing enterprises often co-exist with single vessel owners.

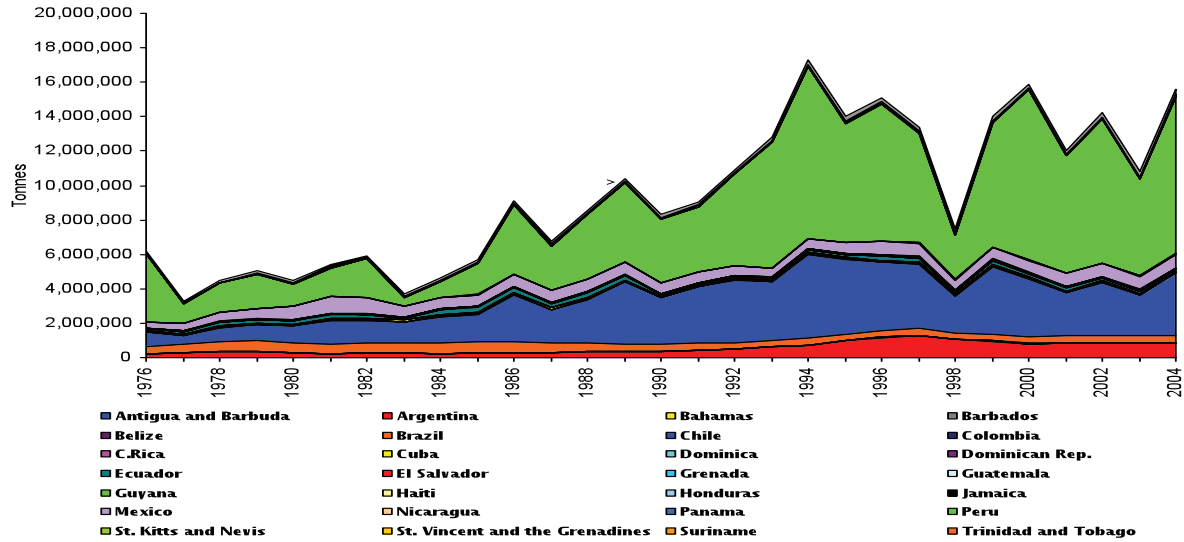
Small-scale Fisheries. Small-scale or artisanal fisheries are generic terms for fishing operations not classified as industrial. They cover a range of activities from subsistence to commercial fishing, from individuals gathering shellfish to multi-vessel fleets using a variety of technologies. Small-scale fisheries may include owners with multiple vessels, but they typically have local ownership. Some are traditional indigenous fisheries; many operate in the informal sector. They are often constrained by limited access to technology and capital. While industrial fisheries contribute the mass of fishery production in the region, some 90% of the region's fishers are small-scale (Reid et al. 2005; Chuenpagdee et al. 2006). Small-scale fisheries often present challenges for fisheries managers due to the large number of small vessels operating out of numerous harbors, often targeting multiple species.

Recreational and Sport Fisheries. These make significant contributions to local income and employment in some places, as well as contributing to foreign exchange earnings through international tourism.

Processing. The processing sector is defined as all 'facilities where raw materials (coming from fleet catches and aquaculture) are changed into final or intermediate products.' The largest and most capital intensive processing operations in Chile are the fishmeal factories. Processing for human consumption is generally more labor intensive. In many cases, processing is vertically integrated with harvesting.

Support Services. Fisheries rely on suppliers of a wide range of products, transport, and marketing services, and other inputs that are not identified as part of the fishery sector. The need for sustainable fisheries and ecosystem management involves government agencies, technical advisory groups, and NGOs as well.

Figure 7.7. Volume of Catches by LAC Fleet in Their Own EEZs (tons)



Source: Sea Around Us Database.

The inherent volatility of the anchoveta fishery can make fisheries time series difficult to interpret, but the long-term smoothed pattern is similar with or without Peru. The value of fisheries production shows a similar pattern from 1976 to 2004, albeit with slower growth and less apparent variability (Figure 7.8).

Figure 7.8. Dollar Value of Catches of LAC Fleet in Their Own EEZs

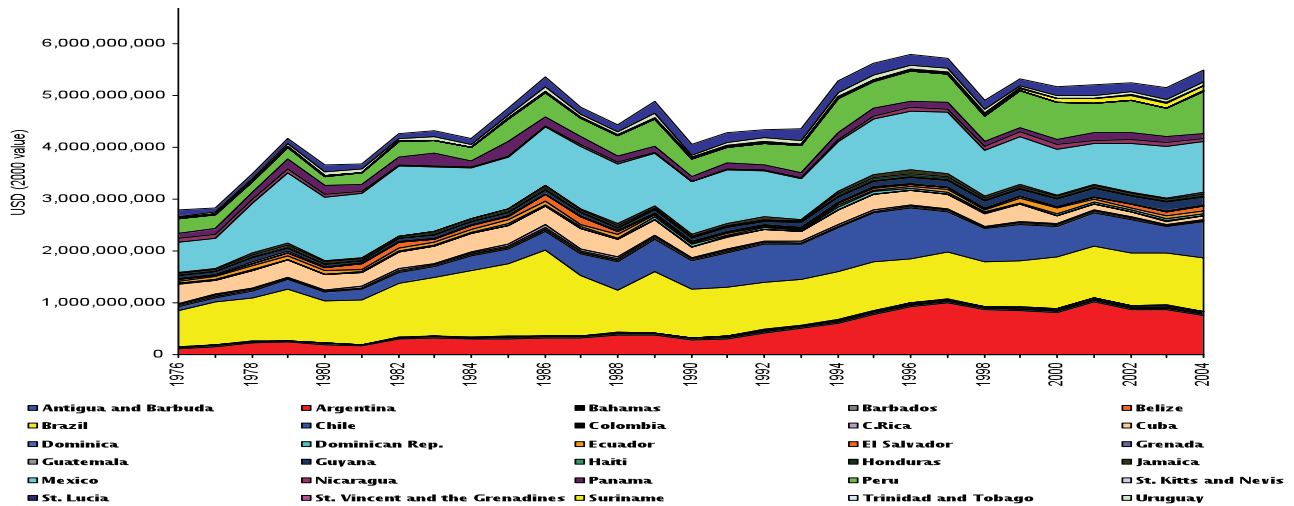


Figure 7.7. Volume of Catches by LAC Fleet in Their Own EEZs (Regional fishing effort roughly doubled from 1970 to 1996, leading to concerns about over-capacity and over-capitalization in many fisheries (Gelchu and Pauly 2007). In 1995, the largest fishing fleets in the region by tonnage were held by Mexico, Panama, Peru, Argentina, and Chile.

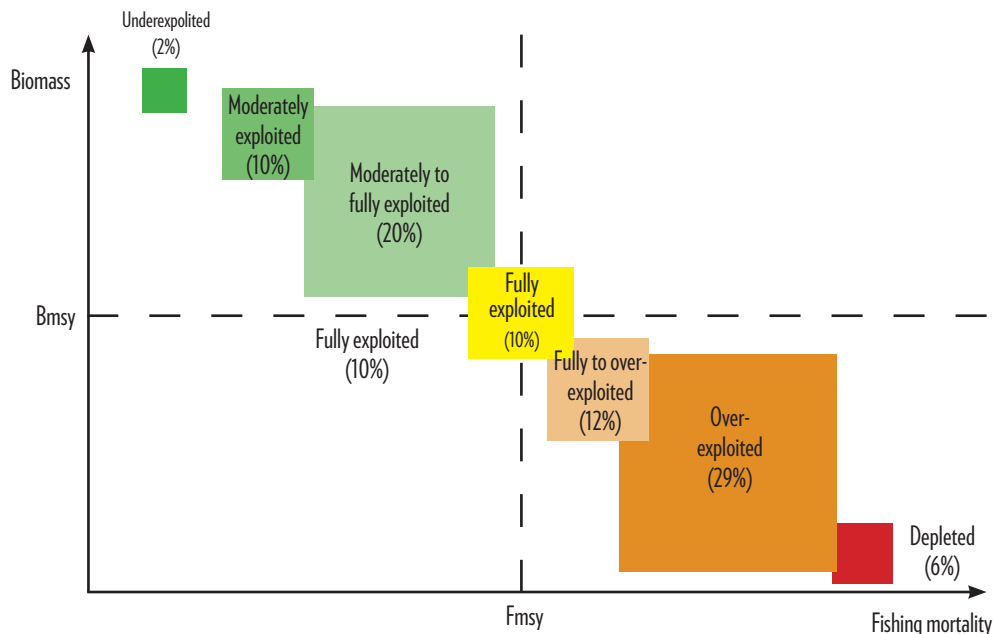
Current Status of Fisheries in LAC

There are several ways to evaluate the status of fisheries, each with its limitations (Hilborn et al. 2003). Examining trends in landings

alone can be seriously misleading (Worm et al. 2009). Apparent stability in landings may mask sequential depletion of individual stocks (Hilborn et al. 2003); whereas changes in landings may reflect changes both in the availability of fish and in fishing effort. Availability likely depends on a combination of past fishing mortality and variable environmental conditions. Fishing effort responds to changes in technology, economic incentives, regulation, and net revenue from previous periods. There is wide variation among species in landing trends; no two species have trajectories alike.

Stock assessments and fishery-independent surveys provide more reliable insights into stock status than landing data alone (Worm et

Figure 7.9. Status of 49 selected fisheries in LAC



Source: After Garcia and Newton 1995, using data in Appendix 5, Status of fisheries in LAC.

al. 2009). Another widely-used approach is to assess the portion of fisheries that are overfished. In LAC, of 49 stocks for which data are available (Appendix 7.5), 2% are considered under-exploited and 10% moderately exploited, with some potential for increased production. About 30% of stocks are moderately to fully exploited, and, therefore, close to their maximum sustainable limits, with a further 12% fully to overexploited. About a third (35%) of fisheries are over-exploited or depleted, while 10% are recovering (Figure 7.9). These percentages imply that in the long-term, higher catch levels in these fisheries could be achieved with less fishing effort, and some inputs could be used otherwise. With most fishery resources fully exploited or overexploited, opportunities for development lie primarily in restoring depleted stocks and harvesting all stocks more efficiently (Hilborn et al. 2003).

These LAC data are mainly for industrial fisheries for which stock assessments have been conducted; thus, the data are not representative of all the fisheries in the region. (See Appendix 7.5 for information on specific fisheries and data sources.) Also this data is 15 years old and evidence suggests that the current situation of stock is significantly worse than in 1995. Stock assessments do not provide direct information on the economic and environmental impacts of current fishing rates; these may vary significantly among fisheries (see Hilborn 2007 for further discussion). In terms of economic impacts, sector data, such as the contribution of fisheries to GDP and to exports, reflect the economic importance of fisheries but do not provide insight into their economic health (Hilborn et al. 2003). A better approach is to estimate the difference between actual and potential economic rent in specific fisheries (Hilborn 2007; World

Bank 2009). (See Part II of this chapter for some examples, and Part III for recommendations on assessing the ecological effects of fisheries.)

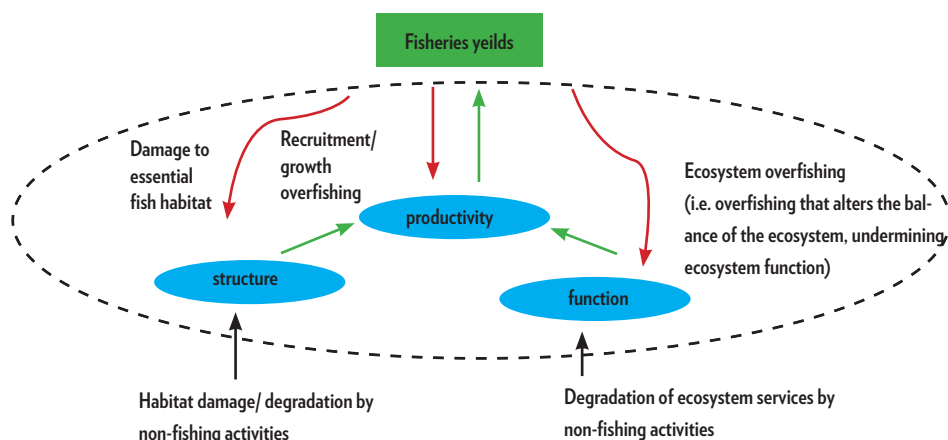
7.4 BUSINESS AS USUAL VERSUS SUSTAINABLE ECOSYSTEM MANAGEMENT

Business as Usual (BAU)

BAU fisheries are those that focus on maximizing short-term gain, externalizing impacts that are long run, indirect, or off the production chain. Thus, these practices tend to deplete fish stocks and degrade essential fish habitat and key ES, leading to loss of economic value. Figure 7.10 outlines some of the feedback loops that effect productivity and yields, including the negative ones (in red) from overfishing, habitat damage, and the undermining of ecosystem function.

Typically, natural resources are exploited at a level that undermines the productive potential of the fishery, drives the fishery to over-exploitation, and/or prevents recovery. Depletion of natural capital in fisheries imposes economic costs on society through lost yields and reduced employment, income, and food security. The underlying causes of resource depletion in BAU fisheries include fishing fleet overcapacity, subsidies that stimulate the development of overcapacity and/or excess fishing effort, and a failure to control illegal,

Figure 7.10. Business As Usual In Fisheries: Feedback Loops



unregulated, and unreported (IUU) fishing. These underlying factors generate additional economic costs to society. BAU practices in fisheries can undermine ecosystem structures and functions by overfishing, damaging essential fish habitat, and by weakening ecosystem services. This leads to negative feedback loops that undermine the productivity of the resource and threaten future yields of the exploited stocks and others. Threats to ES upon which fisheries depend may also derive from outside the sector, as where land-use change leads to sedimentation or eutrophication. Combined, these costs and threats entail a strong mandate on fisheries authorities and national governments to address BAU fisheries to ensure that they remain net contributors to national wealth rather than drains on society (World Bank 2009).

This definition of BAU does not imply that all fisheries in LAC meet this description – BAU refers to poorly-regulated fisheries at the opposite end of the spectrum from SEM, rather than a uniform status quo. Several countries in LAC have started to tackle the challenges presented by BAU practices, implementing strategies to increase the economic contribution of their fisheries and to preserve the ES that underlie them, making progress toward SEM. The impacts of BAU differ among types of fisheries: Table 7.1 (above) lists some threats to the major types of marine capture fisheries in LAC.

Sustainable Ecosystem Management (SEM)

In contrast, SEM practices safeguard ecosystem capacity to provide the ES upon which fisheries and other activities depend, for the purpose of generating optimal sustainable economic yields. In effect, SEM is the set of management practices that maintain marine ES needed to attain those yields.

Fish stocks, underwater habitats and biota, fishing fleets, and fishing

communities are all components of exploited marine ecosystems. SEM in fisheries entails regulating and rebuilding fisheries to maintain and restore productivity. SEM, therefore, builds on both the FAO Code of Conduct for Responsible Fisheries (FAO) and the Ecosystem Approach to Fisheries (EAF) (Garcia et al. 2003; Pikitch et al. 2004), both of which are broadly accepted as the appropriate framework for managing marine capture fisheries.

Ecological Services that Sustain Fisheries

Marine ecosystems (including estuaries, mangrove and seagrass communities, coral reefs, the continental shelf, and the ocean) provide a wide range of goods and services through economic processes. In turn, the economic processes depend on natural services or ES that provision, regulate, and maintain the productive processes exploited by fisheries.

Fisheries depend most directly on the provisioning services of marine ecosystems, but these systems are underpinned by a complex web of regulatory and support functions. Sediment retention is important in reducing sedimentation of near-shore habitats (such as coral reefs), which reduces their productivity. Water filtration services help ensure health of the biota and survival of gametes, fry, corals, and other sensitive organisms, while minimizing accumulation of pollutants up the food chain. Disruption of nutrient cycling services through excessive nutrient loading may lead to low oxygen conditions and dead zones. Degradation of marine ecosystems threatens fisheries and other economic activities that depend on them for many ES. Fisheries management may maintain natural capital or erode this capital through resource depletion and ecosystem degradation; sound management may build up this natural capital through investment in sustaining or rebuilding fish stocks and safeguarding essential fish habitats.

SEM in fisheries provides for safeguarding critical life stages of species and essential fish habitats. This safeguarding requires integration of population and spatial management approaches. Fisheries management to date has focused mostly on maintaining fishery yields through population management, whereas spatial management has focused on identifying areas important for biodiversity conservation and representation of habitats or ecosystems. In many cases, there is limited information on the role of habitats in sustaining fisheries (e.g., which habitats are essential to critical stages of fish life-cycles). Yet safeguarding key habitats may enhance the resilience of fisheries to high levels of fishing effort. The idea of 'fisheries refugia' is to safeguard habitat areas that are essential at critical life history stages of targeted stocks (such as spawning and recruitment), so as to sustain or improve fisheries yields (SEAFDEC 2006). However, even globally, there is limited experience on integrating fisheries management with habitat management or broader ecosystem considerations. This limited information is highlighted by the case studies in this report, which focus primarily on responsible single-stock fisheries management as a foundation for SEM.

SEM also involves attention to maintaining marine biodiversity and the key ES upon which fisheries and other economic activities depend. This attention includes provisioning services (especially fish, molluscs, and other elements of the food chains that sustain capture fisheries and aquaculture, which, in turn, provision humans), regulating services (such as water purification and control of fish population sizes), cultural services (such as cultural heritage, recreation, and ecotourism), and supporting services (such as the water cycle, nutrient cycling, primary production, or fish metabolic, growth, and reproductive processes).

Safeguarding Essential Fish Habitats

Protection of the natural resource base and of the ES that support this base is fundamental to underpinning SEM. The ecosystems and ES that give rise to fisheries are dispersed and not well characterized; fish habitat is a convenient proxy that will encompass many critical elements of the ecosystems.

Essential fish habitats are those crucial for the different life stages of fish species. Of particular concern to fisheries is the loss or degradation of habitats that are critical to spawning and/or recruitment. Mangroves, seagrass beds, coral reefs, and wetlands support a wide range of commercial, recreational, and subsistence fisheries (Postel and Carpenter 1997; Peterson and Lubchenco 1997; McLeod and Leslie 2009). Fishing can contribute to loss of some of these habitats via damage by destructive fishing gear. Bottom trawling, dredging, and trapping can have destructive effects on hard and soft habitats by disturbing soft sediments, simplifying bottom topography, degrading seagrass beds, and destroying corals, oyster reefs, the tops of seamounts, and other hard bottom features (Hilborn et al. 2003).

Ecosystem overfishing may also lead to habitat transformation.

In addition, essential fish habitat may be degraded by activities originating outside capture fisheries, including direct habitat destruction (such as clearing of mangroves) and degradation of essential ES such as sediment retention, nutrient cycling, water filtration, and both current and tidal flow regimes. While many studies assess the value of different habitats to fisheries (see Appendix 7.2), relatively few studies apply a cost-benefit approach to compare the economic contribution of these areas under alternative uses. This section highlights the findings of several studies that do.

MANGROVES

Mangroves are one of the world's most threatened tropical ecosystems. For countries in the Americas with data, 38% of mangrove areas have been lost since 1980 (Valiela et al. 2001). Mangroves act as nurseries for valuable species such as shrimp. Numerous studies have shown the market value that arises from mangrove-dependent capture fisheries. Production of fish and blue crab in the Gulf of California was valued at \$19 million/year in 2001-2005. Mangrove-dependent species account for 32% of small-scale fisheries landings in the region, with landings directly related to the length of mangrove fringe (Aburto-Oropeza et al. 2008). Still, mangroves there are disappearing at 2% annually, due to sedimentation, eutrophication, and deforestation (INE 2005). The annual cost to local fisheries of lost yields of fish and blue crab alone is estimated at \$33,000 / ha of mangrove annually (Aburto-Oropeza et al. 2008).

Gammage (1997) used a cost-benefit framework to compare SEM with alternative use scenarios ('do nothing', and partial conversion to semi-intensive shrimp farming) for mangrove ecosystem services in the Gulf of Fonseca, El Salvador. Results showed that the net present value (NPV) was higher under SEM than in the partial conversion option over a 56-year time frame, with a discount rate of 7%. The main beneficiary of sustainable mangrove management was the industrial shrimp fishery. The study clearly demonstrated the value of protecting the mangrove ecosystem as a nursery ground for shrimp fisheries.

CORAL REEFS

Coral reefs make an important contribution to both fisheries and tourism (Conservation International 2008). They supply only about 2%-5% of the global fisheries harvest, but are a key source of employment, income, and food in the developing world (Chapman et al. 2008). Several studies have assessed the value of healthy coral reefs to fisheries (see Conservation International 2008).

Burke and Maidens (2004) looked at productivity differentials between fisheries located on healthy and degraded reefs. Based on a

literature review, it was estimated that healthy reefs in the Caribbean would support a maximum sustained yield of 4 tons of fish per km² per year. Yields from degraded reefs were estimated at between 0.7 and 2.9 tons per km² per year. Based on these assumptions, maximum sustained yields for 26,000 km² of Caribbean reef were estimated at just over 100,000t of fish per year. It was further estimated that annual fisheries production could decline from 100,000t to 60,000t or 70,000t by 2015 under BAU, representing lost yields of 30%-40%. At market prices of \$6 per kg on average, gross fisheries revenue was estimated at \$625 million/year if all reefs were healthy, declining by \$190 million-\$250 million under BAU by 2015. Net revenues may be only 50% of gross revenues, after accounting for the costs of vessels, fuel, gear etc. The study, therefore, estimated the potential annual net benefits from healthy reefs at \$310 million, with BAU leading to a loss in net income from fisheries of \$95 million-\$125 million/year.

A recent analysis of the regional environmental patterns of and human influence on coral reefs found that coral reef degradation in the Caribbean is reaching thresholds that are probably irreversible, with as little as 10%-30% coral cover remaining in reefs studied (Knowlton and Jackson 2008).

Part II. Economic Analysis

7.5 COSTS OF BUSINESS AS USUAL

BAU management strategies that lead to resource depletion, degradation of essential fish habitat, and loss of ES undermine the economic potential of fisheries.

Part II focuses on the direct costs of BAU, in terms of yields foregone through resource depletion, but also highlights the indirect costs associated with fishing overcapacity; illegal, unregulated, and unreported (IUU) fishing; and ecosystem degradation. Subsidies, intended to augment short-term gains, are examined as drivers of overcapacity, overfishing, inefficiency, and waste that lead to these longer-term losses. Investigation of a range of cases within the region suggests the high costs of these conditions: resource depletion, discarding, fishing overcapacity, inappropriate subsidies, and IUU fishing. Also investigated are the costs of BAU from degradation of essential fish habitat, whether attributable to fishing or not. Case studies from the region that evaluate the costs to fisheries associated with the degradation of regulating and supporting services (such as sediment retention, nutrient-cycling, and water filtration) have not been found. Finally, the emerging issue of the potential impact of climate change on LAC fisheries is explored.

Lost Productivity

The World Bank and FAO recently quantified the total cost to the world economy of lost yields in global marine capture fisheries at two trillion dollars over the past three decades, with losses continuing to accumulate at a rate of \$50 billion per year (World Bank 2009).

Resource depletion is an economic term referring to the exhaustion of a resource, such as a fish stock, within an ecosystem or region. Resource depletion implies that fish stocks are reduced to such low levels that long-term yield is much lower than possible or profitability is much less than it could be (Hilborn et al. 2005). Resource depletion reduces the natural capital (e.g., fish stocks) and the ES that sustain this capital. Together, natural capital and ES are a major contributor to coastal economies. If not addressed, resource depletion leads to low stocks and lowered annual catch levels, with economic rent declining to zero or below. In the extreme, resource depletion can lead to fishery collapse, providing a dramatic illustration of the costs of BAU. Most countries in LAC committed to the recovery of depleted fish stocks at the World Summit on Sustainable Development in 2002 (Beddington et al. 2007).

Resource depletion can be operationally defined in biological terms, with respect to single-species or multi-species maximum sustainable yields (MSY), or in economic terms with respect to maximum economic yield or rent (MEY). Losses from resource depletion may be estimated by comparing yields at current stock sizes with MSY or MEY (Hilborn et al. 2005). From an economic perspective, MEY is a more appropriate target than MSY (Hilborn 2007). MEY is usually achieved at higher stock levels and lower exploitation rates than MSY, because this 'measure' takes into account the costs of fishing (Grafton et al. 2006).

Case studies (Sections 2.3-2.7) show declining yields, and collapse or near collapse under BAU management in LAC fisheries including Argentinian hake, Peruvian anchoveta, and Chilean loco abalone.

DISCARDS, BYCATCH, AND WASTE

Discards of targeted species, bycatch of non-targeted species (including species of commercial value in other fisheries) and ghost fishing by abandoned gear may also contribute to loss of productivity (Crowder and Murawski 1998; Hilborn et al. 2003). Discards and bycatch of commercially-important species are part of the overall catch. These conditions can contribute to growth or recruitment overfishing and reduce future yields; thus, they need to be taken into account into stock assessments. Discarding can cause considerable conflict among different fisheries. Bycatch of non-target species may have significant impacts on the population viability of globally-threatened species or other species of conservation con-

Box 7.2. Maximizing Yields vs Overfishing

Unfished stocks tend to have high biomass levels at which population growth and reproduction rates are low. Fishing at levels that support MSY or MEY lead to the deliberate reduction of stock biomass to levels such as 25%-50% of unfished biomass (Worm et al. 2009). This situation raises population growth rates so that annual increments are maximized and can be sustainably harvested. Resource depletion is caused by overfishing (i.e., fishing mortality in excess of MSY or MEY). It is important to note that fishing inevitably leads to a reduction in stock biomass. As biomass drops, there are fewer conspecific fish with which to compete, and growth and reproduction rates rise, until the MSY biomass is reached. At that point, a further fall in biomass will lower the rate of population resurgence. Overfishing depletes stocks beyond this point and reduces yields and profits.

Overfishing can occur in open access and unregulated fisheries or when the total allowable catch (or other target) is set too high (i.e., strategy failure), when the tactics designed to implement harvest strategies are inadequate (i.e., regulatory failure), or when regulations are not effectively enforced (i.e., enforcement failure). Strategy failure often occurs when there is pressure on fisheries managers to increase or maintain harvest rates above optimal levels, in the context of insecure fishing rights and fishing overcapacity. Scenario analysis indicates the costs of overfishing in the Argentinean hake fishery (Section 2.3). Part III outlines a management system that would reduce this pressure.

Growth overfishing is harvesting fish before they reach the size to maximize yields; recruitment **overfishing** refers to harvesting of adults before they have had sufficient opportunity to contribute to reproduction. Chronic overfishing occurs when stocks are maintained at a low biomass that produces relatively stable catches, but at a level far below the potential productivity of the stock. Under these conditions, fishers face higher harvest costs than would be necessary to harvest more fish from a larger stock with less fishing effort (Grafton et al. 2006). If the fishery remains relatively stable, fishers and managers are likely to regard the current state of affairs as normal and acceptable, succumbing to the 'shifting baseline' phenomenon (Pauly 1995).

cern. This can lead to severely-curtailed international markets for fisheries products. For example, the United States prohibits import of shrimp caught without turtle excluder devices and several major international fish buyers that source fish from LAC have pledged to source seafood from sustainable sources that limit bycatch (e.g., WalMart has announced that it will only sell MSC-certified fish beginning 2011, in the U.S.).

Discarding is usually caused by economic or regulatory constraints — fish are discarded because they are too small or unmarketable, or because they are in excess of a regulatory quota. Discarding is a major problem in many fisheries, with 8% of the world's catch discarded annually (Kelleher 2005). Discard rates vary substantially by fishery and by gear. It is especially high in shrimp and prawn trawl fisheries (Hilborn et al. 2003). In Peru, the average discard rate is about 3.3%, but 81% in the industrial shrimp trawl; in Argentina, discarding is 15% overall, but 24% in the southern hake otter trawl fishery, and 50% in shrimp trawls (Kelleher 2005).

FISHING OVERCAPACITY

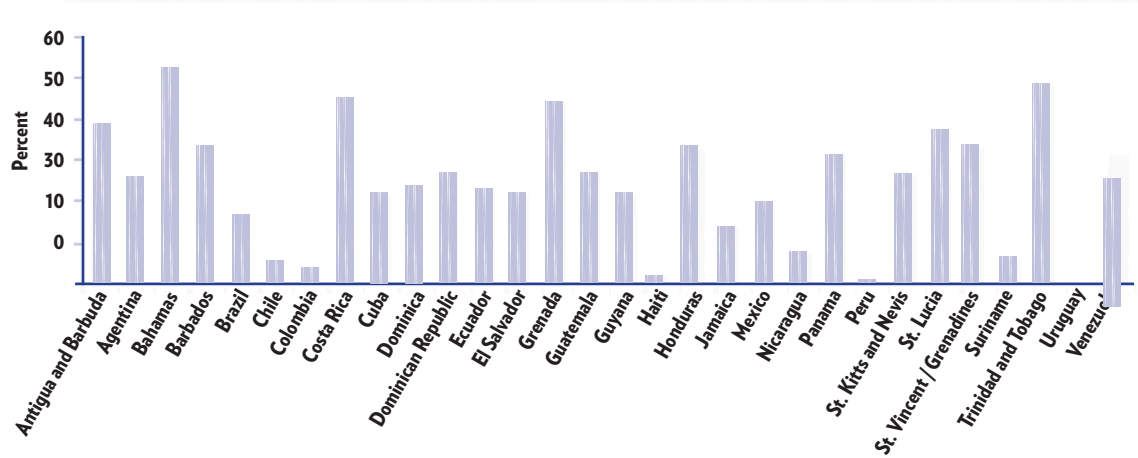
Fishing fleet overcapacity is a major driver of overfishing and resource depletion (Gelchu and Pauly 2007; Villasante and Sumaila 2010). Fleet overcapacity is often a source of pressure to set the total allowable catch (or other target) too high. Overcapacity can fuel an economically wasteful 'race to fish', in which vessels com-

pete to catch the most fish before a fishery-wide quota is achieved (Hilborn et al. 2003). Fishing overcapacity occurs when the fleet size and fishing power is greater than required to achieve the total allowable catch in the time available. It is a long-term phenomenon, distinct from the temporary excess capacity that may occur in any industry subject to fluctuations in the supply of raw materials. Fishing overcapacity is economically inefficient, since capital is tied up unproductively (Garcia and Newton 1995; Stump and Batker 1996; Clark et al. 2005). Fishing overcapacity is characteristic of open access fisheries (Thorpe et al. 2000; Gelchu and Pauly 2007), but may also evolve in limited access fisheries with inadequate control. Overcapacity can develop through overinvestment in fishing capacity, especially during the development phase of fisheries (when fishing down the stock leads to high initial landings). It is often catalyzed by subsidies to fleet development (Hilborn et al. 2003; Beddington et al. 2007). For example, from 1985-1990, Mexico's fleet expansion program included subsidies of \$5 billion (Anon 2005a cited in Gelchu and Pauly 2007). The Peruvian anchoveta case study provides a clear example of the potential scale of costs of fishing overcapacity.

INAPPROPRIATE SUBSIDIES

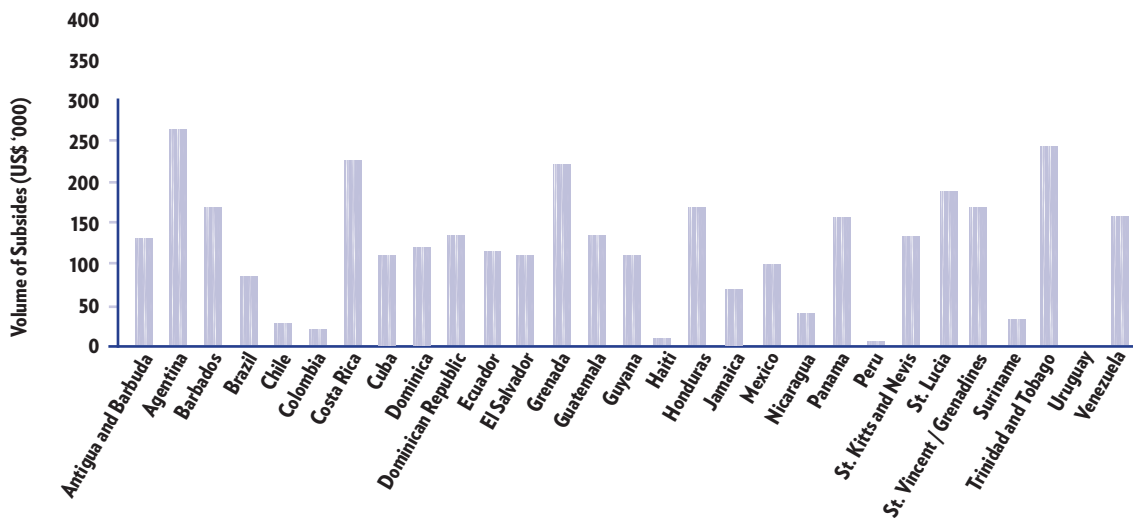
Inappropriate subsidies represent a direct cost of BAU and often promote fishing overcapacity and/or excess fishing effort. If subsidies cover a portion of fishing costs, fishers and fishing firms can continue to make money even if their fishing operations are not

Figure 7.11. Percent Contribution of Fisheries Subsidies to Landed Value by Country



Source: Sea Around Us Database

Figure 7.12. Absolute Contribution of Fisheries Subsidies to Landed Value (Good, Bad, And Ugly) By Lac Country (\$ 000)



Source: Sea Around Us Database

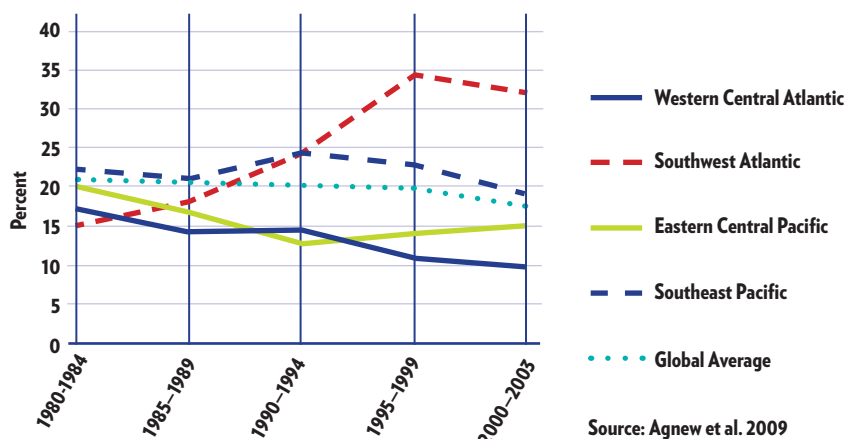
truly profitable (Khan et al. 2006; Beddington et al. 2007). In the absence of subsidies, the cost of fishing must be paid for from fishing revenues. Subsidies may take the form of exemption from fuel and trade taxes, access to low-cost credit, and direct grants for vessel purchase and replacement. Subsidies may provide a useful indicator of economic health — with high subsidies indicating an economically fragile fishery (Hilborn et al. 2003). As a region, LAC is third in the world in terms of total subsidies for fisheries, at \$1.9 billion per year (Khan et al. 2006). Figure 7.11 gives the percent subsidized by countries and Figure 7.12 for the absolute amounts in each country. However, not all fisheries subsidies are inappropriate. Khan et al. (2006) distinguishes between ‘Good’, ‘Bad’ and ‘Ugly’ subsidies. ‘Good subsidies’ lead to investment in natural capital assets, through government-funded fisheries research, management,

monitoring, surveillance, and enhancement. Good subsidies include short-term interventions like habitat restoration efforts or license reduction schemes, designed to alter a system fundamentally so that fishery can be managed sustainably in the future. ‘Bad subsidies’ lead to continued depletion of natural capital, after fishing capacity develops to a point where resource exploitation exceeds the MEY. ‘Ugly subsidies’ have the potential to lead to either improvement or depletion of the fishery resource (Figure 7.12).

ILLEGAL, UNREPORTED, AND UNREGULATED FISHING

Under BAU, IUU fishing contributes to resource depletion and impedes recovery of fish populations and ecosystems at significant

Figure 5.14. Illegal, Unreported, and Unregulated Fishing in LAC Sub-regions



cost to legitimate fishing communities as well as public revenues (MRAG 2005; Agnew et al. 2009). Efforts to reduce fishing overcapacity are often undermined by IUU fishing. In a worldwide analysis of IUU fishing in 54 countries and on the high seas, Agnew et al. (2009) estimated the total losses attributable to IUU fishing at between \$10 billion and \$23.5 billion annually. The level of IUU fishing is inversely correlated with fishery governance, with developing countries most at risk (Agnew et al. 2009). If fisheries management targets and the science behind them are not respected by fishermen and not adequately enforced, widespread illegal fishing can occur (Beddington et al. 2007). This adds significantly to overfishing, depletes fish stocks, and undercuts ES, but — worse — it undermines the rational basis for fisheries management and threatens the development of SEM.

The level of IUU fishing in the Southwest Atlantic ranked second worldwide, comprising about 32% of legal catches (Figure 7.13). Estimates of economic benefits lost through IUU fishing in 2003 are \$117million-\$251 million in the Eastern Central Pacific, \$205 million-\$606 million in the Southwest Atlantic, \$265 million-\$506 million in the Western Central Atlantic, and \$1.08 billion-\$2.31 billion in the Southeast Pacific (Agnew et al. 2009). Many of these losses to IUU fishing occur outside the national EEZs.

Ecosystem Overfishing

Ecosystem overfishing occurs when the balance of the ecosystem is altered, undermining the ES upon which fisheries and other economic activities depend. Overfishing leads to significant and potentially irreversible changes in the structure and functioning of aquatic ecosystems (Murawski 2000 reviews definitions) (Box 5.3).

RISKS OF EXTINCTION AND BIODIVERSITY LOSS IN AQUATIC ECOSYSTEMS

There are growing concerns about biodiversity loss attributable to BAU fisheries in aquatic ecosystems. Such questions have to do with the externalization of costs typical of BAU practices. In marine systems, few global extinctions have been documented, but there is a growing record of species loss on a regional scale (Dulvy et al. 2003). Threats associated with BAU fisheries include overexploitation, bycatch, habitat degradation, and loss of key ES. Such threats to global biodiversity and their solutions are only just beginning to come into focus, as in the case of the development of turtle excluder devices.

Several species at high risk of global extinction are threatened by bycatch in the region, including the vaquita, a harbor porpoise endemic to the upper Gulf of California (Rojas-Bracho et al. 2006), the Waved Albatross, which breeds in the Galapagos and forages over the Ecuadorian and Peruvian continental shelf (Awkerman et al. 2006), and the leatherback and loggerhead turtles (Lewison et al. 2004).

In the Galapagos, the severe 1982/83 El Niño event triggered a major transformation from macroalgal and coral habitats to heavily grazed reefs and urchin barrens. The removal of large lobsters and predatory fish by fisheries leading to reduced predation pressure on herbivorous urchins may have exacerbated this transformation and contributed to the loss of dependent biodiversity. Following this event, the endemic Galapagos damselfish (*Azurina eupalama*) is considered probably extinct and it is likely that a number of other species dependent on macroalgal and coral habitats have seen severe declines (Edgar et al. 2009).

Box 7.3. Ecosystem Effects of Fishing

Marine ecosystems had already been substantially transformed by fishing even before the development of modern industrial fisheries (Jackson et al. 2001). Under BAU, there has been growing concern about the direct effects of loss of top predators by fishing, and the indirect effects of their removal on aquatic ecosystems through trophic cascades (Myers and Worm 2003),¹ or the removal of entire guilds that can have significant negative effects on ES important for fisheries. For example, overfishing of great sharks in the northwest Atlantic led to the release of a mesopredator, the cownose ray (*Rhinoptera bonasus*), and the collapse of the scallop fishery (Myers et al. 2007).

There is also increasing evidence of the effects of overfishing on the structure and function of coral reef systems under BAU. Reef overfishing is generally correlated with substantial changes in ecosystem function, which may lead to losses in the production of fish, shellfish, and other marine goods (Jennings and Polunin 1996). Hughes (1994) describes how a decline in the grazing fishes of coral reefs due to overfishing altered the taxonomic composition of coral reefs in Jamaica, modifying the composition from coral-dominated to algae-dominated reefs.

In general, the effects of fishing on top predators will depend on the decline in their abundance, the extent to which declines are offset by increases in competitors, and the extent to which predation regulates prey populations (Kaiser and Jennings 2001). The same applies to grazers and other guilds. It is generally accepted that an ecosystem approach to fisheries should take the ecosystem effects of fishing into account (e.g., Pikitch et al. 2004). Given the complexity of interactions and responses, experimental management (which may incorporate marine reserves as controls) or ecosystem models are necessary to identify and predict these effects and develop appropriate management strategies.

At the global level, concern has arisen about the process of ‘fishing down marine foodwebs’, in which fisheries development involves a gradual but possibly unsustainable transition in target species from upper-level predators like tunas and billfish to lower-level species such as sardines and anchovy (Pauly et al. 1998). Heavy exploitation of large predators may lower their abundance, making them less efficient to fish, and, at the same time, releasing growth in their prey populations, making these species a more attractive target. Alternatively, fisheries development may be better characterized as 1) the sequential addition of fisheries for lower trophic level species, while continuing to fish upper trophic level species (Essington et al. 2006), or 2) driven by profits, initially targeting shallow-ranging species with high prices and large body sizes, and, then, gradually adding less desirable species to the mix (Sethi et al. 2010).

Many lower trophic level groups, such as shellfish and invertebrates, support relatively high-value, low-volume fisheries. Within LAC, fisheries-scale case studies reveal a complex pattern. For example, in the Argentinean-Uruguayan Common Fishing Zone, there has been a decline in mean trophic level attributable to reduced landings of traditional fisheries resources (such as Argentinean hake), and increases in crustaceans, molluscs, and other fish species such as red crab, scallops, and the slow-growing deep water Patagonian toothfish (Jaureguizar and Milessi 2008). In contrast, off southern Brazil, Vasconcellos and Gasalla (2001) found no evidence of decreasing trophic level in fisheries, due to the collapse of the sardine fishery (relatively low trophic level) and increase in offshore fishing for upper trophic level sharks and tunas. In the Gulf of California, interviews with local fishers indicated a decline in the trophic level of inshore fisheries, attributable to reduced abundance of sharks and grouper, compensated by an increase in offshore shark fisheries (Sala et al. 2004). The economic implications are also likely to be complex. For example, the first case suggests a shift toward lower volume but higher value resources; but the decline in inshore resources and the shift of fishing effort offshore or into deeper waters may raise costs and exclude some fishers.

Fishing may also lead to increased volatility in aquatic ecosystems (Apollonio 1994). Fishing may shift individual species toward faster-growing configurations (higher growth rates, younger at maturity, and truncated age classes) and may disproportionately remove upper trophic level species, which tend to be slower-growing and longer-lived. As a result, fish communities may, in time, become less stable and predictable, with high variability in species biomass. This makes fisheries harder to manage and has economic implications for fisher communities.

Note: Trophic cascades occur when removal of a top predator releases prey populations (second level) that then deplete their own prey (third level), releasing the next level down, and so on (Paine 1980). Evidence for trophic cascades is stronger for freshwater systems that have fewer species. In marine ecosystems, with many generalist species at each level that may switch from prey to predator during their life history, there is limited evidence of trophic cascades (Kaiser and Jennings 2001).

There is also concern about the threats to upper trophic level consumers such as seabirds and pinnipeds from competition with fisheries for forage fish (Duffy et al. 1984). For example, populations of the Peruvian Tern, endemic to Peru and northern Chile, were severely impacted by the 1972 collapse of anchoveta, attributed to a combination of environmental change and fisheries pressures (Schlatter 1984).

TARGET SPECIES VULNERABILITY TO EXTINCTION

For commercial species, it is often argued that economic extinction of exploited populations will occur before biological extinction, and that marine species are less vulnerable to extinction than terrestrial species because of high fecundities and large global ranges (Dulvy et al. 2003). Yet, the high fecundities that typify many marine species do not always translate into high reproductive rates. In commercial fish, adult spawners, generally, produce one to seven replacements per year (Myers et al. 1999), comparable to terrestrial vertebrates. For highly fecund species, the vast majority of larvae fail to survive in most years. Population structures of many commercially-important fish species are characterized by episodic recruitment – low in most years, with strong cohorts in occasional years when conditions are right. Fisheries depend on such strong cohorts, but truncating the age structure of populations by fishing may jeopardize their persistence if short-lived adults have few opportunities to reproduce successfully (Dulvy et al. 2003). While there is limited evidence of recruitment failure at low densities in commercial fish species (often fairly mobile) (Myers et al. 1995), sedentary species that rely on broadcast spawning, such as the white abalone, are vulnerable to recruitment failure when fished to low densities (Hobday and Tegner 2000).

Long-lived, late-maturing species with low reproductive rates are also inherently vulnerable to overfishing (Reynolds et al. 2001). These characteristics are shared by a number of large predatory fishes, such as sharks and sturgeons (Musik 2001). Following a global assessment of cartilaginous fishes such as sharks and rays, 67 species of out of 365 in the oceans surrounding South America (i.e. 18%) are listed as globally threatened (IUCN 2010). Late-maturing species are especially vulnerable when targeted in multispecies fisheries in which other target species are more productive (Myers and Worm 2005).

Restricted-range species are also inherently more vulnerable to both overfishing and habitat degradation than similar wide-ranging species, as highlighted in a recent analysis of threatened species in the Galapagos (Edgar et al. 2009). Among coral reef fish, 9% have a global range of less than 50,000 km² (Roberts et al. in press cited in Hawkins et al. 2000), and most of these populations occupy only a small fraction of this area that provides suitable reef habitat. For restricted-range species, even localized threats may impact their

entire global range. For example, the totoaba is endemic to the upper Gulf of California, and is threatened throughout this restricted range by a combination of past overfishing, habitat degradation, and bycatch of juveniles (Roberts and Hawkins 1999). This vulnerability also applies to species that only depend on specific locations or limited habitats for specific stages in their life cycles, such as species dependent on particular spawning locations, or estuaries and wetlands for nursery habitat. Species that aggregate in large numbers to spawn are often targeted by fishers and may be at risk of local or even regional extinction, as in the case of the Nassau grouper (Sadovy and Eklund 1999).

7.6 CASE STUDIES

Case studies 1 through 3 use three examples from LAC to explore overfishing and resource depletion in specific contexts; the roles of subsidies, overcapitalization, and regulation in regard to common property resources; and measures to facilitate transition from BAU to SEM. These cases have been selected to represent contrasting kinds of fisheries and situations (industrial-artisanal, marine-intertidal, catch shares-none, public sector vertical management-community oriented co-management, etc.).

Case Study 1. Argentinean Hake (*Merluccius hubbsi*), Argentina¹

The Argentinean hake (*Merluccius hubbsi*) is a demersal and benthopelagic species distributed along the continental shelf off Argentina and Uruguay, occasionally reaching Brazilian waters (Aubone et al. 2000). The Argentinean hake fishery is one of the most important commercial groundfish fisheries in LAC. Due to the abundance, broad distribution, and the scale of landings, hake is a driver of fisheries sector development in Argentina. The hake fishery includes more than 50% of Argentinean fishing vessels, about 12,000 direct jobs, and 40% of fisheries exports in recent years, with landings on the order of 400,000 to 600,000t/year (2001-2008) and a landed value of \$146/t in 2004 (Fundación Vida Silvestre 2008; Figure 7.14). This case study summarizes BAU in the Argentinean hake fishery and then explores the potential economic benefits of SEM, based on scenario analysis.

¹ Case study author: Sebastián Villasante, University of Santiago de Compostela and Beijer Institute of Ecological Economics, <sebastian.villasante@usc.es>. The complete case study is available from the author. Data are derived from the RAM II Stock-Recruit database <http://www.marinebiodiversity.ca/RAMlegacy/srdb/updated-srdb/srdb-resources>. The author acknowledges Ana Parma and Daniel Ricard for support in making the data available.

BUSINESS AS USUAL

During the period 1987-1997, landings of Argentinean hake in Argentina increased from 435,000t to 645,000t. Fishing mortality increased from 0.536 to 0.949 north of parallel 41oS and from 0.130 to 0.455 south of parallel 41oS between 1990 and 2003. In response to the growing risks of collapse, the Federal Fisheries Council reduced the total allowable catch (TAC) to 189,000 tons in 1999, compared to 298,000 tons in the previous year. However, ineffective surveillance and control led to continued overexploitation of the stocks (Cedepesca 1999), with recorded landings exceeding the TAC by 87% in 1999 and 93% in 2000. As a result, both the total biomass and landings continued to decline (Figure 7.14).

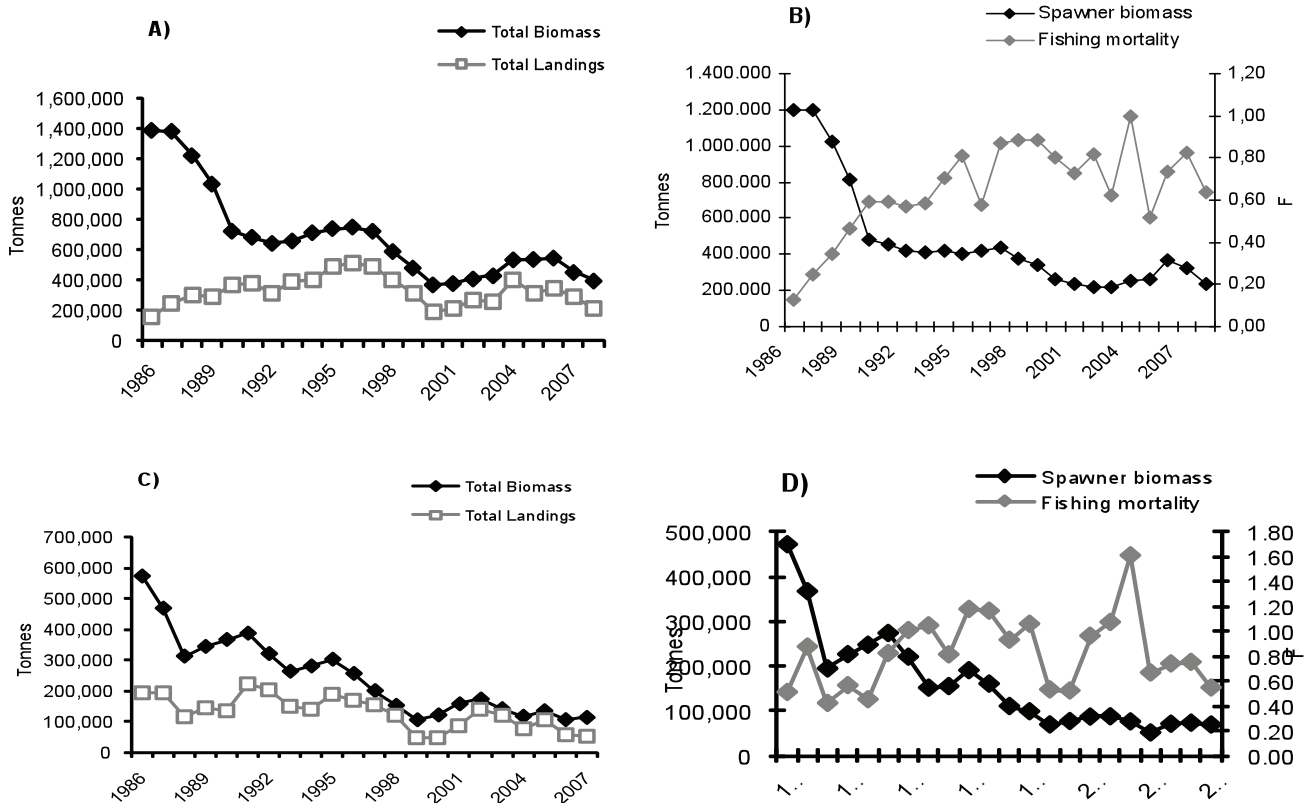
The increase in landings is also attributed to policies of liberalization and opening of the fishing grounds to foreign fleets, largely through an access agreement between Argentina and the European Union (1993-1997). The fishery for Argentinean hake is divided into two fleets. The freezer trawler fleet operates primarily south of parallel 41oS; the fresh fish fleet concentrates north of parallel 41oS. From 1984 to 1997, the fresh fish fleet grew from 126 to 137 vessels, while the freezer fleet went from 44 to 282 (Bertolotti et al. 2001) and saw landings multiply by a factor of 6.6 during 1987-1997 (Irusta et al. 2001). Recent analysis of fishing capacity indicates overcapacity

of 120% (Godelman 2004). At the same time, there has been an increase in discards, mainly juveniles, which represented between 11% and 24% of total landings during the period 1990-1997 (Dato et al. 2006). In economic terms, this represents annual losses of \$11 million-\$77 million. Landings of juveniles increased to 60% of the total catch by 1997. In response to the high percentage of juveniles in landings, a no fishing zone was created in 1997 to safeguard the nursery grounds around Isla Escondida, but this act has had limited impact due to lack of effective surveillance and control. The freezer fleet continued to concentrate around the limits of this zone, therefore, in 1999 the Federal Fisheries Council forced the freezer fleet to move to a zone of lower productivity.

SUSTAINABLE ECOSYSTEM MANAGEMENT

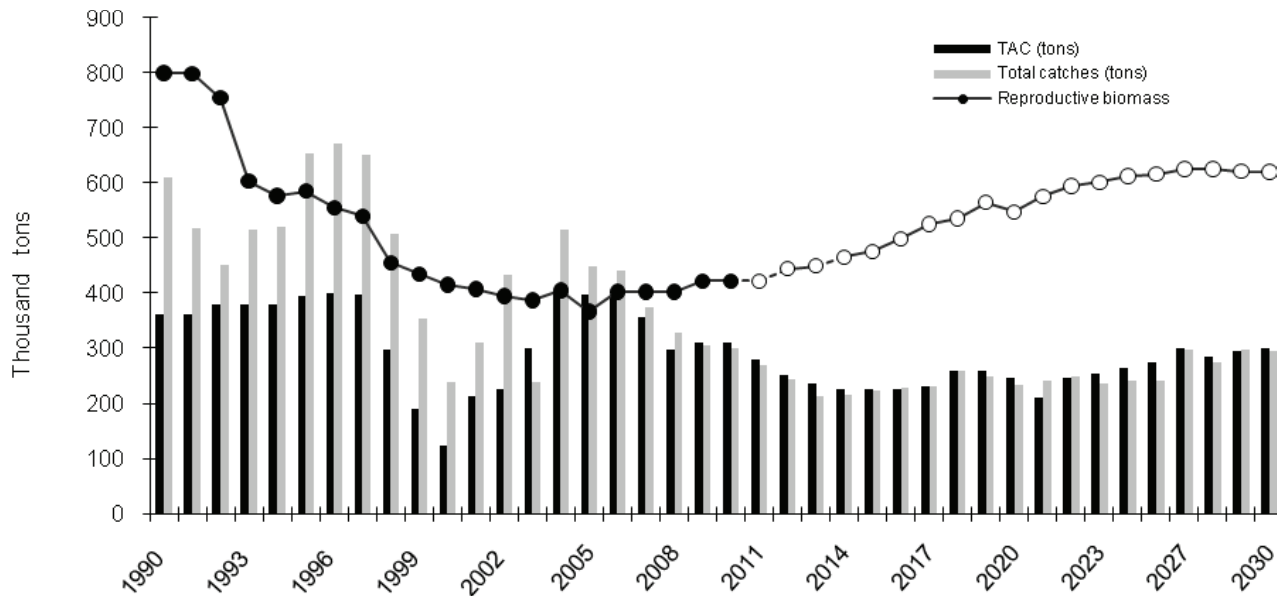
Scenario analysis is useful to explore the potential to increase net economic benefits through responsible management of the Argentinean hake fishery. Two scenarios are contemplated: the current BAU scenario, and a proposed recovery strategy. Currently, the stock biomass is at critical levels, close to the lowest values considered acceptable for the sustainability of the fishery (Aubone et al. 2000). A strategy is proposed that would allow stock to recover to at least an average of 8 million -1.2 million individuals by the year 2030

Figure 7.14. Estimated Biomass and Landings of Argentinean Hake Stocks South (A-B) and North (C-D) of Parallel 41°S



Source: RAM II Stock-Recruit database.

Figure 7.15. Adaptive Recovery Plan for Argentine Hake Fishery, 2010-2030



Sources: RAM II Stock-Recruit database; Villasante et al. (2009).

(the average value observed during the period 1987-1999) (Aubone et al. 2000). This proposal is simply an example for discussion – in practice however, a range of alternative strategies should be evaluated using decision analysis (see Part III on strategy development).

For the recovery strategy, it is assumed that actual landings correspond to the TAC (i.e., that surveillance and control are effective). Increased returns on investment would be supported by the progressive reduction of fishing capacity by 25% in the fresh fish fleet and by 50% in the freezer fleet. This reduction policy would allow for a gradual increase in technological efficiency of 4.4% per year (as per Gelchu and Pauly 2007). Further, a reduction in the discard rate to 8%-20% between 2010 and 2015, and to 3% between 2015 and 2030 is assumed. The scenario analysis is based on an ecosystem model (Ecopath with Ecosim) combined with economic valuation (Villasante et al. 2009). The net present value (NPV) is calculated based on the difference between the value of landings and costs, over a 20-year time frame with a discount rate of 4%. Constant prices are assumed throughout. For the freezer fleet, a cost of fishing of 85.2% of the landed value in the current BAU scenario is assumed (García-Negro 2003) and 72% by the end of the recovery plan. For the fresh fish fleet, costs of fishing of 92% and 85%, respectively, are assumed, in line with similar fisheries (Bertolotti et al. 2001). The reduction in costs takes into account an anticipated increase in catch per unit effort at higher stock levels. The case study focuses on operating costs and treats fishing vessels and processing capacity as sunk costs. The cost of the increased surveillance and control necessary to ensure that landings do not ex-

ceed the TAC and that discards are reduced is not included, due to the lack of estimates. Also, the case study does not take into account the effects on related processing and marketing sectors.

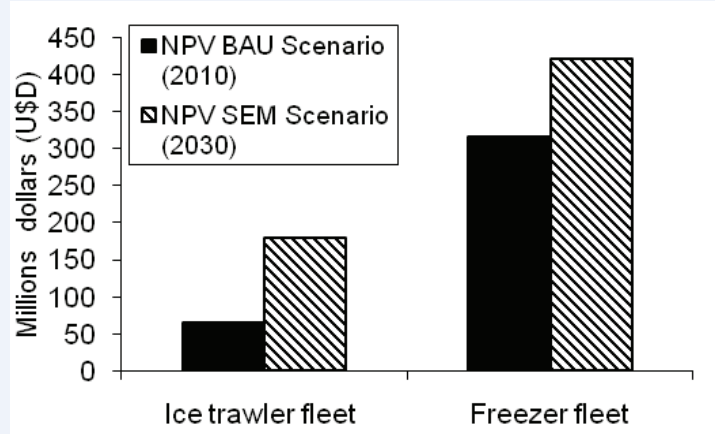
YIELDS AND RETURNS ON INVESTMENT

Under the recovery scenario, the volume of landings is reduced from about 300,000 metric tons in 2010 to 213,000 in 2013, and then rises to 294,000t in 2030 as the stock recovers (Figure 7.15). Yields of the fresh fish fleet rise from about 50,000t in 2010 to 88,000t in 2030; those of freezer fleet fall from 250,000t in 2010 to 206,000t in 2030.

However, despite a reduction in landings from pre-2010 levels, economic yields increase as stocks are allowed to recover through tight control of the TAC and effective implementation of measures to reduce capture of juveniles. Based on a discount rate of 4%, the NPV under the current BAU scenario is \$66 million for the fresh fish fleet and \$317 million for the freezer fleet. In the recovery scenario, the NPV for the fresh fish fleet rises to \$181 million, and for the freezer fleet, \$422 million (Figure 7.16). This increase in economic yields is a function of the reduced costs of fishing (per ton of landed fish) anticipated from the combination of stock recovery and reduced fishing effort (that implies lower labor and capital needs). This enhanced economic yield represents substantial increases in returns on investment, especially as the capital invested in each of the two fleets is reduced over time (by 25% and 50%, respectively). Also, stock recovery is likely to reduce the risk of collapse of this economically-important fishery.

Given the anticipated increase in yields, implementation costs that

Figure 7.15. Adaptive Recovery Plan for Argentine Hake Fishery, 2010-2030



Case Study 2: Peruvian anchoveta (*Engraulis ringens*), Peru¹

The Peruvian anchoveta (*Engraulis ringens*) is a small pelagic fish distributed off the coast of Peru and northern Chile. The Peruvian anchoveta fishery is the largest single species fishery in the world, accounting for approximately 10% of global marine landings (with annual yields between 6 and 8 million tons) (Hatzios and de Haan 2006). The fishery has long been characterized by extreme variability associated with inter-annual and inter-decadal oscillations and occasional collapse (Fréon et al. 2008).

Fishery management for the northern stock of Peruvian anchoveta (north of parallel 16oS) is based on a TAC set with reference to a constant escapement strategy. Each year, acoustic surveys are used to assess current biomass, and the TAC is set to ensure escapement of 5,000,000t (Fréon et al. 2008). In addition, fishing is banned during the two main reproductive seasons and when a high percentage of juveniles are found in the catch. Industrial fishing is also banned within five miles of the coast to protect anchoveta spawning and the habitat of other commercially-valuable species. Together, these measures have served to avoid resource depletion in recent years and reduce the risk of collapse; thus, these measures already represent substantial progress toward SEM. However, the aggregate TAC has also stimulated an economically inefficient ‘race to fish’ and massive overcapacity in both the harvest and processing sectors. In 2009, individual catch shares were introduced to address these problems. This case study focuses on the transition of the fishery from an aggregate TAC to a system of individual catch shares. The first fishing season under the new regime took place in April-June 2009.

² Case study author: Carlos E Paredes, Instituto del Perú, cparedes@intelfin.com.pe. The complete case study is available from the author.

are not included in this analysis should be recoverable from the fishery, while still allowing profits to increase. A more detailed analysis of costs under various scenarios would be required. (See the Peruvian anchoveta case study for an example of capacity reduction and cost recovery to cover the costs of reduced employment in fisheries.)

BUSINESS AS USUAL

The first major crisis in the industrial fishery for Peruvian anchoveta occurred in the early 1970s. Overfishing, resulting from exponential growth of the fleet and inadequate regulations, was exacerbated by the effects of the severe 1972-73 El Niño (Hilborn and Walters 1992). This crisis led to the nationalization of the industry. Following a period of stagnation, the fishery was re-privatized in the early 1990s. Despite efforts to limit fishing capacity, including the 1992 General Fishing Law that explicitly prohibited expansion of the fishing fleet and processing capacity, privatization led to substantial new investment in construction of new vessels and plants, as well as modernization of existing capacity. The 1997 El Niño left the highly-indebted industry on the brink of collapse once again. This crisis set off a process of mergers and acquisitions that led to increased vertical integration and concentration within the industry. Seven companies now account for approximately two thirds of the storage capacity of the steel-hulled fleet and 70% of the processing plant capacity.

By the end of 2007, the industrial fleet boasted a total storage capacity of approximately 210,000 cubic meters, while fish meal and fish oil plants had a total processing capacity of 8,909 tons per hour. To demonstrate the magnitude of the industry’s overcapacity, it is worth noting that under ‘normal’ conditions (i.e., without the presence of the El Niño phenomenon), total anchoveta landings fluctuate between 6 and 8 million tons per year (for example, in 2006-2008,

TABLE 7.2. ESTIMATES OF FLEET AND PLANT EXCESS CAPACITY

MEASURED IN REFERENCE TO:	2006-2008 AVERAGE		2006 TAC	
Fleet and plant efficiency	60%	80%	60%	80%
Fleet's excess hold capacity	60.5%	70.4%	70.9%	78.2%
2006 fleet's hold capacity/optimal capacity	2.5	3.4	3.4	4.6
Plants' excess processing capacity	65.3%	74.0%	74.4%	80.8%
2006 plant capacity/optimal capacity	2.9	3.8	3.9	5.2

Source: Paredes and Gutiérrez (2008).

anchoveta landings averaged 6.02 million tons). In 2006, the TAC was set at 5.9 million tons. If the fishing efficiency coefficient (which corresponds to the portion of the vessel's hold capacity that is filled in each fishing trip) is set in the 60%-80% range, then the excess fleet capacity was between 60% and 78% in 2006. In other words, the actual size of the fleet's hold capacity was between 2.5 (assuming a 60% fishing efficiency coefficient and TAC of 6.02 million tons) and 4.6 times (assuming an 80% fishing efficiency coefficient and TAC of 5.9 million tons) its optimal size (see Table 7.2). Because take drives processing rates, the excess processing capacity of the associated fishmeal plants fell within a range of 65% to 80%. This implies that the installed plant capacity represented 3 to 5 times its optimal level.

Thus, BAU in the Peruvian anchoveta fishery was characterized by overcapacity in both the harvesting and processing sectors, with progressively larger capital stock lying idle over progressively longer periods. Using detailed cost structure data for 2006, Paredes and Gutierrez (2008) estimated that foregone profits in the sector exclusively attributable to excess fleet and plant capacity were significant. They concluded that cutting the fleet's hold capacity and the plants' processing capacity by half (which would have not sufficed to eliminate excess capacity in the sector) would have led to doubling the sector's aggregate profits — a net gain of approximately \$400 million per year. The economic inefficiencies associated with overcapacity in the harvest and processing sectors substantially reduced returns on investment, and as a result, the sector currently makes a relatively small contribution to Peru's tax revenues. According to official figures, the fishing sector's fiscal contribution under BAU was extremely low — only \$68 million in 2006, or 4.8% of the value of fishmeal and fish oil exported that year.

SUSTAINABLE ECOSYSTEM MANAGEMENT

In 2008, the Peruvian Government introduced individual fishing rights over the anchoveta biomass by setting a maximum catch limit per vessel based on a percentage of the TAC. The main goals were to address the issue of fleet overcapacity and eliminate the race to

fish, as fishers would no longer try to catch as much fish as could fit in the vessels' holds as fast as possible before the TAC was reached.

Quotas for each vessel were set based on its average catch during the 2004-2008 period and by the hold capacity (for steel-hulled vessels). Rights are non-transferable, but several provisions in the new legal framework allow consolidation of catch shares by vessel owners (for example, owners may temporarily consolidate quotas among vessels during a fishing season and permanently, if one is scrapped) (Aranda 2009). This is a necessary condition for the least efficient vessels to retire from the fleet. To prevent displacement of fishing effort, a further decree in March 2009 extended the system to the southern fishing zone (south of parallel 16°S). This represented the first time that a TAC was applied to this fishing area.

To mitigate the social costs of transition, the legislation established three programs: (a) worker retraining incentives, (b) development and promotion of micro and small-sized companies for displaced workers, and (c) early retirement provisions. These programs are financed by two mandatory contributions payable by the beneficiaries of the new fishing rights: (i) an annual adjustable fee imposed on the holders of fishing permits, fixed for the first year at about \$12 for each 0.001% share of the TAC (for steel-hulled vessels) and (ii) a fee of \$1.95 per ton of fish landed in processing plants. To put these fees in perspective, the first would raise about 0.12% of the value of the landed anchoveta, while the second would account for 0.2% of fishmeal sales. These contributions are small when measured against the increase in profits under the new regime, but demonstrate the potential for financing programs to address the social costs of transition by recovering a portion of the economic benefits of improved fisheries management.

IMPACTS ON YIELDS

There was no change in the procedure for setting the TAC north of parallel 16°S, thus no change in yields was anticipated. As discussed in Part III, catch shares are designed to strengthen incen-

tives to guard against resource depletion. The Peruvian anchoveta fishery has long suffered from overcapacity, which places pressure on management to increase the TAC despite the risks of eroding the natural capital upon which the fishery depends. The introduction of secure catch shares is expected to reduce this pressure.

The catch share system has effectively eliminated the race to fish, with an increase in the length of the fishing season, and lower average and maximum daily fish landings. (Under the new catch shares regime, the first fishing season in 2009 was 102 days, versus 33 days in 2008.) This has led to increased selectivity (evidenced by a lower percentage of juveniles in the catch), improvements in the quality of the fish, and a greater share of high-protein fishmeal (prime and super-prime) in total fishmeal production.

One emerging concern is that individual quotas may have created new incentives to under report landings. The surveillance and control system probably needs to be strengthened to address this reporting problem. If not, otherwise successful efforts to avoid resource depletion may be undermined.

IMPACTS ON EMPLOYMENT

The industrial fleet currently employs approximately 18,000 fishers for about four months per year over two fishing seasons (Aranda 2009). Legislative Decree 1084 included a series of measures to prevent massive and uncompensated crew layoffs during the first two years of the new regime. Therefore, it is still too early to assess the impact on employment. However, expected is this: that reductions in overcapacity for both the harvesting and processing sectors will lead to a decline in the total number employed. Catch shares have led to a significant increase in the length of the fishing season. This will probably lead to a restructuring of employment in the harvesting sector, with a reduction in the total numbers employed at the peak of the season, but longer-term and more secure employment for those who remain.

IMPACTS ON RETURNS ON INVESTMENT

Returns on investment are expected to greatly improve by reduction of overcapacity in both the harvesting and processing sectors (on the order of 60-80%). Reducing fixed costs (capacity) is fostered by quotas that let production be spread over a longer period. That production time frame change allows for smaller investments in vessels and factories, which can be used more fully during the year. In the harvesting sector, the quota mechanism works directly by allowing fewer vessels to be used to fill each quota — the result is that the vessels used are more efficient. As fleet overcapacity declines and catch shares are consolidated among fewer, more efficient vessels, returns

on investment for vessel owners should increase.

In processing, the effect of the quotas will also be to consolidate the sector, in turn, reducing fixed costs and raising returns on investment. This outcome will happen in two ways: (1) by spreading production over a longer period, so that owners of multiple facilities can use the more efficient facilities and eliminate the rest, and (2) by competition for raw material. The introduction of catch shares led to a hefty increase in the price of anchoveta — a rise of nearly 50% in 2009 over 2008, despite a drop in fishmeal prices of more than 25%. With a guaranteed catch share, fishers are now able to time their fishing trips to match demand, thus avoiding the traditional glut at the beginning of the season. This has increased the price of fish to vessel owners, even though there was no change in overall supply or demand (represented by the TAC and the installed processing capacity). In contrast, the price of fishmeal is determined in global markets which integrate the supply of fishmeal from Peru with a wide range of other factors. This price competition for raw material implies a reduction in profits for processors, especially independents (those not vertically integrated with fleets), which should lead to the exit of the least efficient processors, a reduction in total processing capacity, and rising returns on investment for the remaining processors — given that the TAC will be shared among fewer plants operating for longer periods.

FISCAL IMPACTS

At present, there are no documented fiscal impacts from the introduction of catch shares. Given that returns on investment for vessel owners are expected to increase substantially, a part of these returns could be recovered through increased license costs and other cost-recovery measures as well as increased revenues from corporate income taxes. Some of the additional revenue may need to be invested in adapting the existing surveillance and control system to the new quota-based harvesting system.

EQUITY

In contrast to the fishing sector, the new legal framework did not provide additional incentives to reduce overcapacity in the processing sector. This framework reflected the belief that reduction in the processing capacity would take place smoothly as a byproduct of the change in the harvesting regime. There is considerable vertical integration in the industry, implying that, for several processors, the costs are offset by benefits to the fishing arm, but companies with a low fleet/processing capacity ratio are at risk. Industry concentration has grown and is likely to increase further, as firms with low fleet/plant ratios are absorbed by larger ones and/or become insolvent. The legislation does not include provisions to address social costs in this sector, and those negatively affected are seeking to revoke the

legislation. This issue clearly needs to be addressed. One way would be to establish a fund to cover transition costs in the processing sector, financed by the processing plants that remain and benefit from increased returns on investment. This impact highlights the need to consider the downstream effects of fisheries reform during the transition towards SEM. Opposition from the processing sector has created uncertainty about the permanence of the reform, and may jeopardize some of the expected benefits until resolved — such as reduction of fleet capacity.

CHALLENGES

A significant consequence of the change in the fishing regime, boosted by higher anchoveta prices, is the substantial increase in the incentives to evade regulation and to under-report fish landings, in order to avoid exhausting the individual legal quota. In addition, the small-scale fishing fleet that is not legally allowed to land fish for indirect human consumption, is landing anchoveta for fishmeal production and expanding rapidly. This highlights the need to take into account the likely responses of other fishing fleets when moving toward SEM. An increase in IUU fishing is indicated by the apparent reduction in the fish-to-fishmeal conversion factor — most plausibly explained by an increase in unreported

landings. If that is the case, this situation would jeopardize the success of the new management system, leading to overages of the TAC that might threaten sustainability of the fishery. The expected benefit of a catch share system is predicated on effective surveillance and control. Peru's system will need to be adapted and strengthened to deal with these new incentives. The anticipated growth in returns on investment within the industry suggests the potential to finance strengthened surveillance and control through cost recovery.

A remaining policy challenge is to catalyze reduction in overcapacity in the processing sector that will lead to a higher return on investment for remaining processors and reduce incentives for IUU fishing.

This case study has focused on efforts to reduce overcapacity and eliminate the race to fish in the Peruvian anchoveta fishery. These measures do not directly address fishery impacts on the broader ecosystem, such as possible competition between the fishery and top predators dependent on anchoveta, including upper trophic level fish, seabirds, and marine mammals. However, the reforms provide an essential platform on which appropriate interventions may be built, given that introducing measures to safeguard ecosystems in fisheries characterized by overcapacity and excess competition can be extremely difficult.

Case Study 3. Chilean abalone (*Concholepas concholepas*), Chile

The loco abalone (*Concholepas concholepas*) is a benthic gastropod which inhabits the intertidal zone. Artisanal benthic shellfisheries have played an important role in the socio-economic development of Chilean coastal communities (Castilla and Defeo 2001). During the 1970s and 1980s, the fishery evolved from one primarily oriented toward domestic consumption with annual landings averaging 3,000-6,000t to one oriented primarily towards Asian markets, with a rapid increase in annual landings to a peak of 24,800t in 1980. This transition led to growing pressure on the resource, overharvesting stimulated by price increases, and, finally closure of the fishery from 1989 to 1992 (Castilla 1994). This case study summarizes the economic benefits associated with transition of the loco fishery from one of open access to one managed through territorial use rights in fisheries (TURFs) and co-management.

³ Case study author: Sebastián Villasante, University of Santiago de Compostela and Beijer Institute of Ecological Economics, The Royal Swedish Academy of Sciences, <sebastian.villasante@usc.es>, from whom the complete study is available.

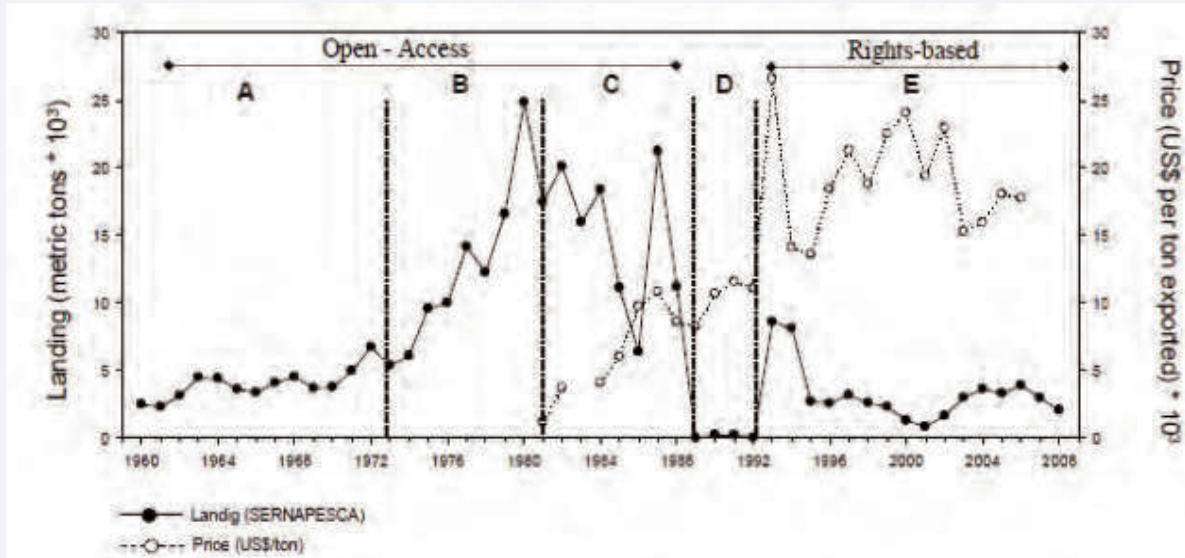
BAU

BAU in the loco fishery was characterized by open access, overharvesting as prices increased, and eventual collapse. The open access regime enabled artisanal fishers to migrate along the coast in search of viable resources, often leading to conflict between locals and outsiders (Castilla and Gelcich 2008). The evolution of the fishery is traced in Figure 7.17.

SEM

The 1991 Fisheries and Aquaculture Law enabled the creation of areas for the management and exploitation of benthic resources, known as AMERBs. Exclusive non-transferable use rights over benthic resources up to five nautical miles from the coast could now be granted to registered artisanal fishing associations. The law also imposed a moratorium on new entrants to the fishery and restricted artisanal fishers to working in the area of their residence. Harvesting of loco is restricted to areas managed by AMERBs (Castilla and Gelcich 2008). The new management regime reoriented incentives toward sustainable management. The benefits of responsible management extend beyond the loco abalone to cover other species managed by the AMERBs (Defeo and Castilla 2005). By 2005, there were 547 AMERBs established in Chile, of which 301 had approved management plans and were fully operational (Defeo and Castilla 2005).

Figure 7.17. Landings and Exports of Loco Abalone (1960-2008)



Source: Gelcich (2009).

AMERBs are founded on the principle of co-management. Harvest quotas are fixed based on scientific assessments and harvest plans developed collaboratively by fishers, scientists, and management authorities (Castilla and Gelcich 2008). Concerns have been raised about the ecological effects of harvesting invertebrates on the structure and diversity of intertidal and near-shore subtidal communities (Leiva and Castilla 2002). While the focus of co-management has been on sustainable management of targeted resources, ecological knowledge gained from experimental management of AMERBs has been used to inform management strategies (Defeo and Castilla 2005).

YIELDS

During the AMERB phase from 1993-2005, landings have fluctuated around 2000-5000t — levels similar to those before the export phase and collapse — and are considered sustainable (Castilla et al. 2007). Population densities inside AMERBs were found to be higher

than in neighboring open access areas, and the catch per unit effort has increased from 15-143 to 280-540 individuals per day. Also, the size of individuals has grown from 103-108cm in the open access period to 110-117cm under co-management (Defeo and Castilla 2005).

FISCAL IMPACTS

Some of the costs of transition to the new regime have been absorbed by fishing associations. In particular, fishing associations must cover the costs of baseline studies upon which TACs and management plans are based, and pay external consultants to undertake annual stock assessments. They also pay an annual fee to the government in return for the rights to management areas (Castilla and Gelcich 2008). AMERBs have catalyzed active participation by fishers in surveillance and control within each association, and have led to a reduction in illegal fishing, which is attenuating government enforcement costs (Castilla and Fernandez 1998; Defeo and Castilla 2005).

benefits are less clear and/or the costs are high. The priority placed on transitioning fisheries toward SEM depends on the significance of expected economic and environmental impacts.

7.8 NET ECONOMIC BENEFITS OF SEM

“With effective economic incentives, rather than being a net drain on the global economy, sustainable fisheries can create an economic surplus, be a driver of economic growth and a basis for livelihood opportunities.” (World Bank 2009)

For some fisheries, the net economic benefits of SEM are evident and transition costs are relatively low, whereas in other fisheries, the

Yields

Depletion and fisheries collapse can incur high costs in terms of lost yields, as well as impacts on employment and other indicators. SEM aims to avoid these costs by investing in maintaining or restoring natural capital and reorienting fisheries management toward MEY.

For fisheries currently managed for MSY, net economic benefits will increase at MEY, even with slightly lower yields. Maintaining stock biomass at the higher level associated with MEY is also likely to promote greater stability with respect to both biomass and yields (Worm et al. 2009). In this context, the costs of SEM are likely to be less than the costs of chronic overfishing and risk of collapse followed by a long and uncertain period of recovery.

For fisheries characterized by severe resource depletion, moving toward SEM will involve a temporary reduction in yields (and other economic indicators), but successful rebuilding will lead to increased yields over the long term. Alternative rebuilding plans (such as complete cessation of fishing over a shorter time-frame versus a reduction in fishing effort over a longer time-frame) can be evaluated in terms of their cost-effectiveness under different discount rates. The case studies of Chilean loco abalone and pirarucú in Brazil provide clear evidence of the potential for improvements in yields from SEM. In each case, BAU led to the collapse and closure of the fishery. SEM has enabled both fisheries to reopen, with annual yields that are considered sustainable (Castilla et al. 2007; Viana et al. 2007).

Employment

As with production, restructuring national fisheries to be more economically efficient may require an initial reduction in employment, given that overcapacity (including labor capacity) is a major aspect of inefficiency in the sector. Specific effects on employment will depend on the issues to be addressed. For example, elimination of the race to fish may lead to a restructuring of employment to fit the need for a lower level of human-power over a longer fishing season. In Peru, the introduction of catch shares led to an increase in length of the first fishing season in 2009 to 102 days from 33 days in 2008. Temporary measures to prevent high unemployment, funded from gains in earnings, have buffered the transition. Addressing cases of chronic overfishing may lead to an increase in employment, sometimes in relatively short times. In the Brazilian Amazon, BAU led to closure of the pirarucú fishery. SEM has led to an increase of 75% in the number of fishers employed in the fishery (from 1999 to 2005; Viana et al. 2007). In general, SEM practices were seen to lead to employment opportunities that are more durable than those seen under BAU.

The costs of transition are likely to be lower in regions where the local economy is growing and alternative employment opportunities are already available. Reduced direct employment in the harvesting sector may be compensated for by additional employment in the processing sector, if investment in value-added post-harvest processing forms part of the steps towards SEM, or in other industries that benefit from SEM (such as tourism or other recreational activities). Such adjustments could create a more diversified employment base and reduce overall vulnerability.

Returns on investment

SEM reorients fisheries management objectives toward maximizing net economic benefits. Under BAU, resource depletion, fishing overcapacity, inappropriate subsidies, and the race to fish create fisheries that are economically inefficient. Under SEM, the rebuilding of fish stocks, the reduction of fisheries capacity to levels that match the productivity of the resource, reorientation of subsidies, and (where possible) an elimination of the race to fish all serve to increase returns on investment over the long-term. In the long-term, SEM fisheries will reduce fishing effort, increase catch per unit effort, and improve the economic efficiency of fisheries.

Scenario analysis of the Argentinean hake fishery indicates the increase in economic yield that may be attained by reduced fishing effort and reduced harvesting of juveniles. The Peruvian anchoveta case study shows how better returns on investment may be realized by eliminating the race to fish. In this second example, the mechanism involved — the potential decrease in fixed costs with reduction of overcapacity (estimated at 60%-80%) in both the harvest sector and the processing section plays out in two ways: directly in the case of the harvesting component, and indirectly for the processors. The dynamics of the latter are reflected in a sharp increase in the price for anchoveta offered to independent vessel owners, implying a reduction in profits for independent processors that should lead to elimination of excess processing capacity.

Fiscal Impacts

SEM emphasizes increased investment in science and management capacity (including surveillance and control). At the same time, SEM often involves the reduction of inappropriate subsidies, which can release funds for investment in fisheries management. In addition, moving fisheries toward MEY generates increased returns on investment in the fishery, provides new opportunities for cost recovery, and improves the tax base. Case studies of the Peruvian anchoveta and Chilean abalone fisheries provide examples of increased public cost recovery under SEM. (See those case studies and Section 3.4 on financing SEM.)

The net economic benefits of SEM are likely to be higher if BAU subsidies represent a substantial fiscal cost and where the additional costs of management and control are offset by improvements in yields and a reduction in IUU fishing, both of which increase taxable business income.

Equity

It is difficult to generalize about the equity impacts of transition toward SEM. In the near term, management changes are likely to cre-

ate both winners and losers. Successful transition may depend on finding ways to limit economic hardship during the transition and mitigate costs to those who lose. The case study of Peruvian anchoveta provides some insights into the complex equity issues of transition to SEM.

Fisheries can be an essential source of food security, employment, and income; fisheries may provide a critical safety net for the vulnerable. Mining the resource base may be an effective short-term strategy for individuals (and countries) to move out of poverty, but sustainable resource use is a necessary condition for fisheries to contribute to poverty reduction over the long run (FAO 2007). The poor are disproportionately vulnerable to fisheries depletion and collapse because they lack economic alternatives; thus, they poor may benefit from the increased security of fisheries-based livelihoods associated with SEM. The distributional implications of fisheries management options, in particular changes to access rights, must be considered when developing SEM strategies. (See Box 5.5 below on options for pro-poor fisheries management).

7.9 CLIMATE CHANGE CLEAR CHALLENGE, UNCERTAIN CONSEQUENCES

The Inter Governmental Panel on Climate Change projects that the global temperature of the Earth will rise by 1.1–6.4 C° by 2100 (IPCC 2007a). Temperature changes projected for ocean surface waters vary greatly (Nicholls et al. 2007). Global ocean-atmosphere models that forecast oceanographic changes are too broad to predict impacts on specific aquatic ecosystems or fish stocks. Development of regional models at scales relevant for fisheries management is an active area of research, but there is still great uncertainty. For example, various authors have predicted that El Nino events may become more frequent and severe under global warming, while others have suggested that increased upwelling in the Humboldt Current system might make El Nino less severe (Bakun and Weeks 2008).

The direction and scale of impacts of climate change on specific fish stocks and fisheries is thus uncertain (Allison et al. 2009). Long-term climate fluctuations and shorter-term climate variability clearly affect fish stocks and ecosystems (Cushing 1982; Peterson et al. 2002). Under global warming, ecosystem productivity is likely to be reduced in most tropical and subtropical waters, and increased in high latitudes (FAO 2009). Changes in ocean circulation may disrupt patterns of reproduction, migration, and connectivity, as well as community and ecosystem relationships

(IPCC 1998). Empirical observations show that marine species respond to environmental variations by modifying their latitudinal distribution and depth (Dulvy et al. 2008). Local shifts in production and species mixes are anticipated. Ocean acidification will affect calcareous corals and shellfish, and reef-based fisheries, with crustaceans and molluscs especially vulnerable (Hoegh-Guldberg et al. 2007; Guinotte et al. 2008). Species with large populations, high reproductive rates, short generation times, and high ecological flexibility, are likely to adapt most rapidly (Ferreira et al. 2004). The effects of fishing will interact with those of climate change as fishing reduces the size of stocks, lowering their capacity to adapt. Reducing fishing mortality in overexploited fisheries is one of the main ways to reduce the impacts of climate change (Brander 2007).

At a country level, the vulnerability and adaptability of national economies to climate change depends on the economic importance of the fishing sector, the economic dynamics of fishing fleets and fishing communities, and their capacity to adapt. A recent global study identified the economies of Peru and Colombia as highly vulnerable to the impacts of climate change on fisheries (Allison et al. 2009). A study by the Central Bank of Chile (Medel 2009) emphasized the potential negative impacts of increased variability in fish stock biomass associated with climate change, especially if rates of ecological change are faster than rates of capital conversion and / or are unpredictable. Fisheries management will need to be adaptive and capable of responding rapidly to changes in the resource base (Allison et al. 2009). See Part III for further discussion of adaptive and responsive management systems.

Part III. Conclusions and Recommendations: Moving Toward SEM

The principal conclusions of this chapter are that

- Further economic growth in LAC fisheries is likely to come through rebuilding depleted fisheries, restoring essential fish habitat and ES, and improving economic efficiency. This implies continuing and extending the switch toward SEM.
- BAU in fisheries causes economic losses through stock depletion, habitat damage, and degradation of ES. In some cases, the same or higher yields could be captured with less effort, thereby freeing up capital and other resources, and raising rates of return.
- SEM in fisheries addresses these problems through responsible management of single and multispecies fisheries. In particular,

SEM reduces overfishing and overcapacity, cuts harmful subsidies, realigns incentives, and safeguards essential ES and fish habitats. SEM in fisheries, thus, enhances the economic contribution of fisheries through provision of food, employment, and income on a lasting basis.

The main recommendation is to foster the transition to SEM, which in fisheries requires several steps:

- 1) An enabling policy and legislative framework;
- 2) Stakeholder involvement to ensure buy-in and transparency;
- 3) Responsive management strategies based on the best available science, adaptive management, and a precautionary approach;
- 4) Effective implementation that combines incentives to align private interests with policy objectives, with regulatory controls and with effective enforcement; and
- 5) Stable, well-managed institutions with secure, adequate funding.

These recommendations are further developed in the following sections, with an eye to guiding formulation of specific policies and tools to facilitate a switch to SEM. Responsible management of single and multispecies fisheries is integral to SEM, a necessary first step toward wider goals. If systems are inadequate for the management of single species fisheries, then they will not be able to cope with the demands of ecosystem management. Fisheries may be prioritized for transition to SEM based on expected economic and environmental benefits. Successful transitions will, generally, be incremental.

7.10 DEVELOPING MANAGEMENT STRATEGIES OF SEM

The following sections set out a framework for building fisheries management systems that enable and encourage fisheries to be managed consistent with SEM.

Goals and Objectives of Fisheries Management

The purpose of this section is not to define appropriate objectives for specific cases, but to explore approaches to attaining both economic

and ecological ends by improving economic efficiency, while protecting against negative feedback loops and safeguarding aquatic biodiversity and ecosystems. Many well managed fisheries are both biologically sustainable and economically profitable (Hilborn et al. 2005).

Fisheries management goals have been evolving and broadening, from maximizing yield and employment to improving economic efficiency and reducing impacts on ecosystems. Traditionally, biological goals cover maximum sustainable yield (MSY) and, more recently, protection of non-target species and ecosystems. Economic goals usually focus on maximizing returns. Social goals include employment, income distribution, food production, and maintaining livelihoods. Economic and ecological goals may be compatible in that both are achieved at exploitation rates lower than MSY (Grafton et al. 2006; Hilborn 2007).

Different stakeholders — industrial, traditional, and recreational fishers — will have different objectives (Hilborn 2007) and perceive the condition of ecosystems differently, depending on the value they attribute to distinct services and outputs. A crucial intermediate goal is to reduce pressure by fishers to maintain high harvest rates even at the risk of depleting resources and degrading ES. This means ensuring that stakeholders have a long-term interest in productivity and that the needs for effective surveillance and control, as well as management capacity, research, and funding needs are met.

Broad goals for fisheries management should be set in national-level legislation (FAO 2007). In Argentina, for example, the Federal Fisheries Law aims to maximize value from the fishery, maximize the employment of Argentinean labor, and provide incentives for the long-term conservation of fisheries resources. Legislation should also provide guidance on priorities. Strategy development will require trade-offs — if these trade-offs are not clear in law, they will be made by decision makers. Strategies need to be translated into operational objectives, such as preventing resource depletion, rebuilding fisheries, reducing overcapacity, realigning incentives, controlling IUU fishing, and limiting discards, by-catch, waste, and habitat damage.

Performance indicators to monitor progress should also be defined. If fisheries managers are to adopt SEM practices, then this professional practice needs to be reflected in their performance frameworks. A fisheries manager whose performance will be evaluated only against MSY and job numbers cannot be expected to invest scarce resources in broader ecosystem management.

Enabling Legislation

Many LAC countries already have strong legal frameworks that provide an enabling environment for SEM (Pitcher et al. 2009). However, in some cases, high-level legislative change may be necessary to support and stimulate progress toward SEM. Purposes to be pursued may include the following:

- 1) Establish the goals for fisheries management (e.g., improve economic returns, avoid irreversible ecosystem harm).
- 2) Provide guidance on translating fisheries goals into quantitative management objectives (e.g., whether fisheries management should be oriented towards MSY, MEY, or some other measure).
- 3) Incorporate the principles of the FAO Code of Conduct for Responsible Fisheries and other relevant instruments.
- 4) Require authorities to prioritize fisheries that are not meeting those goals (e.g., economically-inefficient fisheries or those that have negative ecosystem impacts) and to develop effective strategies and management plans for them.
- 5) Require that management authorities take action to protect threatened species, to identify and safeguard essential fish habitat, and to minimize by-catch and habitat damage;
- 6) Require a precautionary approach — management systems that move conservatively and respond adaptively to changes in the resource base.
- 7) Clarify institutional mandates and jurisdictions, and establish both responsibilities and accountability standards, with appropriate levels and spatial scales of decision making.
- 8) Set high standards of stakeholder participation, oversight, and transparency.
- 9) Require other agencies to consult fisheries authorities on activities that would impact productivity, critical fish habitat, and essential ES.
- 10) Define access rights and provide the legal basis for privileged access schemes (e.g., catch shares) and co-management, if appropriate.
- 11) Establish adequate and secure funding for fisheries management activities by public agencies, including stock assessment, monitoring and research on fisheries, and ecosystem management. Revenue generation and retention through license fees and other cost-recovery mechanisms may require legislative support.
- 12) Ensure that fisheries authorities have adequate authority and resources for effective surveillance and control. Strengthen measures to control IUU fishing, including improved prosecution procedures and increased sanctions. Legally mandating compliance with the FAO Code of Conduct on Responsible Fisheries would provide an international legal basis for economic and other sanctions to discourage illegal fishing (Agnew et al. 2009), and support cooperation among countries and agencies. In addition, it may be useful to set standards and procedures at a regulatory level for the process of strategy development, the formulation of management plans, stakeholder participation, and the development of accountability and transparency measures.

Prioritization of fisheries

Successful transition to SEM will generally be step-wise, fishery by fishery. This incremental transition can be effective if resources and capacity are scarce. Such a transition enables lessons learned in previous rounds to be applied to the next. As new fisheries are added, it is essential to ensure that objectives and strategies are consistent,

taking into account interactions among stocks, and the cumulative impacts on biodiversity and ES.

Economic health, ecosystem impact, data availability, and institutional capacity can provide the basis for prioritizing fisheries for transition toward SEM. The World Bank/FAO study “Sunken Billions” (WB 2009) recommends that countries conduct economic health

checks of fisheries. Information on the ecosystem effects of different fisheries should also be taken into account to prioritize them for transition toward SEM. Smith et al. (2007) outline a qualitative approach to ecological risk assessment. Fisheries with potentially calamitous impacts should be high priorities for transition to SEM. Prioritizing fisheries where gains clearly outweigh the costs and a constituency for reform can be built will be critical to success.

Strategy Development

Responsible fisheries management is undermined by the ratchet effect, leading to strategy failure. Fisheries managers often face substantial pressure to increase harvest rates when productivity is high, but also to maintain harvest rates in the face of declining productivity (Ludwig et al. 1993). A key move toward responsible fisheries management is to establish a process for strategy development that enables and encourages fisheries managers to set appropriate controls despite this pressure (Botsford et al. 1997). Once a strategy is set, it is important to fix quantitative targets, limits, and a timeframe for the operational results.

MSY is no longer considered an appropriate target (Punt and Smith 2001). For most fish stocks, the yield is similar over a range of stock sizes near the MSY point, but with very different consequences. Lower stock levels dramatically increase the risk of collapse, without substantial gain in long-term yields. Greater stock sizes are often favored because yields are only slightly lower while the economic performance of the fishery is usually better. At higher stock levels, catch per unit effort may rise, reducing fishing costs and raising profits (Hilborn et al. 2003; Worm et al. 2009). Larger stocks also provide a buffer against environmental variation, and mitigate impacts on the ecosystem. Thus, targets may be set at biomass levels that support MEY or above, taking into account the ecological role of fished resources.

Pre-defined decision rules based on a combination of targets and limits can enable fisheries managers to resist pressure to set inappropriate harvest rates for depleted resources. Harvest control rules, such as constant fishing mortality and constant escapement are examples of strategies that aim to achieve the management objectives of fisheries. These simple rules can be agreed in advance and applied semi-automatically. Once agreed upon, decision rules can reduce conflict over annual quotas and avoid delaying action to recover depleted stocks (Beddington et al. 2007). Given the uncertainty inherent in fisheries management, the precautionary approach implies that responsible fisheries management be designed to respond effectively to changes in the resource (Hilborn and Walters 1992). Harvest control rules can be devised to achieve this 'automatically' by adjusting the TAC to changes in biomass.

For example, the Peruvian anchoveta fishery is now managed through a constant escapement harvest control rule — the fishery is closed when spawning biomass is estimated to have been reduced to the level needed to support adequate recruitment for the next season (Fréon et al. 2008). Each season, the TAC is set by applying the harvest control rule to estimates of current stock biomass. Where fisheries-specific data is not available, rules of thumb can be used to set limits. For example, fishing effort may be automatically reduced if biomass falls below the level of MSY or MEY, or a moratorium established if biomass falls to levels likely to incur serious risks of low recruitment and possible stock collapse (Hilborn et al. 2003).

Decision analysis can be used to assess the possible outcomes of different decision rules and other management strategies (Seijo 2007). Where significant uncertainty exists about the state of the resource or other factors likely to influence outcomes, decision analysis defines alternative 'states' (e.g., IUU fishing is controlled or not) by assigning relative probabilities to each possible state (e.g., 50:50). Possible decision rules or management strategies are identified and outcomes for each of the proposed states are predicted. This analysis can, of course, include outcomes related to the objectives of SEM, including impacts on essential fish habitats and ES. The results provide guidance on the expected outcomes from different strategies (see Box 7.4). Decision analysis is most often applied to single species or multispecies fisheries, but can be applied to entire ecosystems (Smith et al. 2007), especially by using more qualitative approaches.

Fisheries management requires knowing the status of exploited stocks (Beddington et al. 2007; Seijo 2007). Investment in stock assessments and independent surveys is critical to track stock status, set evidence-based targets and limits, and manage adaptively. Assessments of current stock status can strengthen the efforts of fisheries managers to set appropriate harvest rates and foster support among stakeholders. It is much harder for fishery managers to restrain harvest rates when the status of the stock is poorly known (Botsford et al. 1997). As far as possible, fishers should be involved in fisheries research. Under the precautionary approach, greater care should be applied in managing fisheries when information is uncertain. This gives fishers an incentive to reduce uncertainty through investment in research. The effects of management on stocks should be monitored and strategies changed as appropriate. Ideally, this would involve a process of active adaptive management (e.g. Sainsbury 1991), but for many non-spatially-structured fisheries experimental management is infeasible. Alternatively, strategies can be tested via computer simulation in management strategy evaluation, a form of decision analysis (Smith et al. 1999).

Box 7.4. Decision Analysis

Anda-Montañez and colleagues (2010) recently explored different management strategies for the Pacific sardine (*Sardinops sagax*) off Mexico. To address environmental uncertainty, they defined four ‘states of nature’ in relation to the multivariate ENSO index – ‘normal’ conditions prevail, El Nino-type conditions prevail, La Nina-type conditions prevail, and conditions cycle between normal, El Nino, La Nina, and back to normal – and set probabilities for each of these states occurring. They then explored five different management strategies: open access, effort set at MEY, catch set at MSY, constant effort (2004 levels), constant catch (2001 levels). They then evaluated fishery performance using each of the management strategies under each of the states of nature, with Net Present Value (discount rate = 4%) as the performance indicator. The table below summarizes the results.

STRATEGY	STATE 1: NORMAL	STATE 2: EL NINO	STATE 3: LA NINA	STATE 4: CYCLE	EXPECTED VALUE	VARIANCE
	P1=0.36	P2=0.18	P3=0.18	P4=0.28		
OPEN ACCESS	246,608	35,612	451,107	194,891	230,958	1.60E+10
MEY	222,709	113,896	368,655	190,902	220,487	6.24E+09
MSY	95,507	-9,650	78,179	83,492	70,096	1.43E+09
CONSTANT EFFORT	235,841	113,434	399,223	199,104	232,930	7.87E+09
CONSTANT CATCH	26,437	-44,347	21,488	22,997	11,842	6.96E+08

The results of this analysis indicate that a risk-neutral decision maker (i.e. on who seeks to maximize the expected value and is not concerned about variance) would select the constant effort strategy. (Fisheries scientists can develop and present such analyses, but decisions remain the responsibility of decision-makers.)

A study by Hasenclever et al. (2002) shows the potential for using decision analysis even in a data-poor context. The analysis was on the freshwater pacu (*Piaractus mesopotamicus*), one of the most intensively harvested fish in Brazil’s Pantanal. It represents about 40% of the commercial harvest, and is caught by nearly 80% of tourists to the region. Landings have been declining by approximately 18% per year under BAU management. This study focused on estimating species economic value and the loss in future values if it disappeared. Decision analysis was used to evaluate alternative strategies. The value of the commercial fishery was estimated by multiplying the average annual landings per fisher by the number of registered fishers. For the recreational fishery, the net value of each visit was estimated based on survey data, taking into account indirect effects through the tourism industry. The study used this to compare the value under BAU and under sustainable management. In the absence of data on maximum sustainable yields of pacu, two alternative ‘states’ were considered: MSY occurs at 50% of current harvest rates, and MSY occurs at 75% of current harvest rates. The expected economic value over 20 years with a discount rate of 6% is presented in the Table. Lacking data on the likelihood of the alternative states, equal probabilities are assumed.

Decision Analysis For PACU

	STATE 1: MSY @ 50% OF CURRENT YIELDS	STATE 2: MSY @ 75% OF CURRENT YIELDS	EXPECTED OUTCOME
	PROBABILITY = 50%	PROBABILITY = 50%	
BAU	R\$37,160,000	R\$37,160,000	R\$37,160,000
SEM	R\$70,540,000	R\$105,810,000	R\$88,175,000

Source: Modified from Hasenclever et al. (2002).

Even with limited data on the economic contribution of the fishery, and despite uncertainty about MSY, the analysis provides clear guidance to decision-makers on the relative value of expected outcomes under BAU versus SEM.

Management Plan Development: Clarity, Buy-in, Accountability

A formally adopted management plan with predefined decision rules for how to respond under different circumstances is an important component of successful fisheries management (Beddington et al. 2007). Most management plans aim to achieve the following:

- set out the operational objectives, performance indicators, targets, and limits;
- specify the decision rules or management strategies (e.g. constant harvest rate);
- establish the tools (e.g. quotas, gear restrictions, incentives for reducing bycatch) to be used in implementing the strategy;
- provide fishery-specific details on user rights and responsibilities, and allocation instruments;
- set out the monitoring and research plan and the process for evaluation and adaptive management;
- provide fishery-specific details on enforcement mechanisms.

Effective participation by stakeholders in development of operational objectives and in evaluation of alternative management strat-

egies is likely to be important for success. Management systems that exclude fishers are more likely to overlook practical options and encounter resistance to change than those that actively involve fishers (Hilborn et al. 2003). As far as possible, stakeholders should have a long-term interest in the resource. For SEM, it is important that all affected by fishing have a voice, including those outside the fishery. The process of identifying the full range of stakeholders and facilitating their participation needs to be defined prior to strategy development.

Orensanz et al. (2005) describes participation by federations of artisanal fishers from two regions in the development of a five year management plan for the sea urchin (*Loxechinus albus*) fishery in southern Chile. Formal interviews with a range of stakeholders were used to identify key aspects of the fishery that could help in strategy design, including the potential to manage by combination of measures: rotating harvest areas, monitoring recovery rates, using a size limit to balance reproductive contribution with market demand, and extensive fisheries refugia. The government then brought major stakeholders (fishers, processors, managers, scientists) together to discuss the fishery's future. This led to formation of a technical committee representing all stakeholders. A small technical advisory team drafted a management plan, to which stakeholders agreed, based on access control, experimental rotation, and refugia creation.

Box 7.6. Pro-poor fisheries management

InFAO (2005) describes several measures to support pro-poor fisheries management:

- Ensuring that fisheries management goals are consistent with pro-poor management: In developing countries, high employment may be a legitimate goal, as long as it is compatible with sustainability of the resource (Beddington et al. 2007). But, maximizing employment is likely to involve trade-offs with economic efficiency. Appropriate balance between objectives may vary by fishery and should be made clear in legislation.
- Developing access and allocation systems that enable the participation of the poor in fisheries: Countries may consider zoning systems that provide preferential access to some fishing grounds to small-scale fisheries. In Peru, for example, the industrial purse-seine fleet is restricted from fishing within five miles of the coast. Community-based access management may be one way to regulate access without eliminating the valuable safety net role played by open access fisheries.
- Facilitating effective participation by low income and marginalized fishing communities in decision-making, and decentralizing management responsibilities (including co-management where appropriate).
- Investing in improved post-harvest processing and marketing capacities: Inadequate infrastructure and limited access to credit are major constraints preventing fishers in remote regions from securing the full market potential of their products. Investments in these areas could not only improve incomes associated with fisheries but contribute more broadly to rural development and economic empowerment, especially of women who are often involved in post-harvest processing and marketing.
- Fostering research and development programs that are oriented toward the needs of low-income fishers and that involve them as participants.000).

7.11 REALIGNING INCENTIVES FOR SEM

For SEM, it is essential that fishers and other stakeholders have a long-term interest in the resource. Achieving this will require a three-pronged approach: incentive-based approaches, complemented by more traditional regulatory tools (in particular, access control), and effective surveillance and control measures.

One of the main factors underlying fisheries resource depletion is the frequent misalignment between the private incentives of fishers and the incentives that reflect public economic and ecological objectives. Thus, one way to reduce resource depletion is to re-align private incentives with public objectives, by providing secure user rights, removing perverse incentives, and creating positive incentives for SEM (e.g., via market certification).

Regulatory Tools

The regulatory tools used to implement fisheries management strategies include access controls (below), area management (such as refugia), input controls (like gear restrictions, season lengths, and effort limits) and output controls (annual catch quotas, size limits). In most fisheries, a combination of tools is applied — a system of checks and balances to achieve fisheries management objectives and mitigate risk (Grafton et al. 2006; Beddington et al. 2007). The appropriate combination will depend on context, especially the feasibility of surveillance and control for different tools. Fishers often respond to one type of restriction by expanding effort in other ways. For instance, a major tool for industrial fisheries management is the TAC within some time period. In some cases, setting a TAC has led to a race to fish that is both economically inefficient and damaging to ecosystems. Catch shares is a tool that addresses this issue, as was the case with the Peruvian anchoveta. Another well-established form of output control is size limits, although effectiveness depends on selective fishing practices that avoid catching and discarding individuals outside the size limits. These measures are often used to prevent harvesting of juveniles or the harvesting of mature females that are important for recruitment.

ACCESS CONTROLS

Access control plays a key role in generating incentives for sustainable management. The economic interests of fishers depend critically on access rights (Hilborn 2007). Without access control, the future benefits of sustainable management are likely to be dissipated, thus undermining sustainability.

Open access regimes have also been a major factor in developing overcapacity (Gelchu and Pauly 2007). However, if the number of vessels in a fishery is limited but individual catches are not, then fishers often find other ways to increase fishing power (Hilborn et al. 2003).

Access to most industrial fisheries in LAC is formally controlled through licenses. For example, Chilean law defines four fisheries regimes: general access, full exploitation, fishery recovery, and fisheries in development. The first two require a fishing permit for the vessel owner. For fisheries under full exploitation, a catch limit per vessel owner is in place. The last two regimes are based on fishing permits obtained through public auction under a transferable quota system (Gelcich 2009). In some cases, such as the Peruvian anchoveta fishery, efforts to limit the number of licenses have been circumvented. Access to small-scale fisheries with many vessels operating out of multiple ports is difficult to control and is often effectively open access (Salas et al. 2007). In the absence of legal limits, traditional access limitations may exist and can provide a valuable basis for management (Orensanz et al. 2005; Castilla and Defeo 1998).

Incentive-based approaches

CATCH SHARES AND TURFS

In theory, incentives-based or rights-based approaches to fisheries management realign private incentives to fit national economic interests. The private incentives arising from competition for a common property resource lead actors to use the resource fully in the short-term with no concern for its future. If future access to a fishery resource is insecure, private incentives promote overfishing, overcapacity, and a race to fish (Beddington et al. 2007). In contrast, once each actor knows what its share of the catch will be, improved income will be achieved not by catching more, but by guarding against resource depletion and economic inefficiency. Secure tenure creates an incentive to invest in the underlying fish stock and maximize fishing revenues over a longer time-frame, by eliminating excess capital and fishing effort. Thus, rights-based approaches are used as a tool to reduce capacity and build efficiency.

Incentives-based approaches are not usually based on true property rights — marine resources are typically held in public trust under national laws — but on access privileges that allow individuals or groups to use the resource. These privileges may be subject to performance standards and accountability. They include catch shares (individual quotas, individual transferable quotas [ITQs], community development quotas, enterprise allocations) and territorial use rights in fisheries (TURFs) (Branch 2009). LAC is home to a variety of catch

share systems. Chile has made extensive use of them, with catch share systems now in place for squat lobster (since 1992), black hake (1992), yellow prawn (1997), orange roughy (1997), anchovy, common sardine, and jack mackerel (all 2001) (Aranson 2002; Costello et al. 2008). The early biological performance of the Chilean ITQs has been promising. After four years of ITQ management, exploitable biomass in the squat lobster fishery increased from 15,500t to more than 80,000t, with parallel growth in TACs (Bernal et al. 1999; Cerda-D'Amico and Urbina-Veliz 2000). In terms of economic performance, Gomez-Lobo and colleagues (2007) estimate that over a 20-year horizon, ITQs will produce additional benefits between \$123 million and \$366 million, compared to less efficient management schemes. This magnitude of lost value to be recaptured by ITQs is in line with estimates of \$50 billion lost in fisheries worldwide by mismanagement (World Bank 2009). Catch shares have also been initiated for the Peruvian anchoveta (see Section 2.3), and Argentinean San Jose Gulf scallop fishery (Orensanz et al. 2007).

Typically, small-scale fisheries in LAC have a large number of operators based at many ports, often targeting multiple species. In this context, individual catch shares may not be practical, and area-specific community-based management, such as TURFs, may be more appropriate (Orensanz et al. 2005). Examples include Chilean loco abalone (see Section 2.4), Mexico's red rock lobster (discussed below under certification), and Mexico's Punta Allen spiny lobster. The latter is run by a local fishing cooperative, as are other spiny lobster fishing grounds. The Punta Allen cooperative created private incentives for responsible management by allocating areas to individual fishers. The result has been a long-term trend of stable catch, while data for the other cooperatives show drastic fluctuations. The spiny lobster fishery still lacks a firm harvest quota, instead relying on a seasonal closure and fishers' own incentives not to overharvest their areas.

The potential for displacement of fishing effort to other fisheries can be addressed by introducing catch shares across multiple fisheries (as in Chile and Peru), or by ensuring that adequate measures are

Box 7.7. Fisheries Co-Management: Attributes for Success

Co-management systems engaging multiple stakeholders have been developed in a wide range of fisheries in LAC. A variety of fisheries management tools have been used under them, such as TURFs (e.g., Chilean loco abalone), fisheries refugia (e.g., sea urchin reproductive refugia in Chile [Orensanz et al. 2005]), and other area-management systems, as with pirarucú. Co-management can pursue resource management objectives (such as reduced resource depletion, rebuilt stocks, and improved yields), economic objectives (increased contribution of fisheries to local livelihoods and the broader economy) and social objectives (equity, coastal community development). Gutierrez et al. (in review) have analyzed factors that contribute to success of co-management initiatives in LAC and elsewhere.

Success factors vary by ecosystem, resource type (e.g., benthic, demersal, pelagic; single or multi-species), type of users (small-scale or industrial fishery), co-management framework (consultative, cooperative, delegated), and management attributes (monitoring, control and surveillance, local agency support, etc.). Salient factors, especially for meeting socio-economic goals in small-scale fisheries of developing countries, include social attributes such as leadership, community cohesion, and trust. Effective co-management requires time and resources. Participants need assurance that benefits outweigh costs. Tracking effects on fisheries resources and other targets can contribute. For example, monitoring populations of pirarucú has helped prove the benefits of SEM to both fishers and management authorities (Viana et al. 2007). Building on existing institutions may facilitate development of effective co-management. Capacity-building for stakeholder organizations (e.g., fisheries associations) and staff of participating agencies may be needed. Low-cost conflict resolution mechanisms may need to be set up. Boundaries of managed areas should be well-defined.

The scale of intervention should match that of the resource (Hilborn et al. 2005). Local management is more appropriate for sedentary and/or spatially-structured resources (Castilla and Defeo 2001), such as abalone and lobster. However, coordination among local organizations is essential for managing meta-populations (Orensanz et al. 2005). Pelagic resources that mix over large areas need to be managed at broader scales. A supportive legal framework is also essential for empowering fisheries associations or local organizations to set and enforce resource management rules. Local surveillance and control may need to be backstopped by government enforcement, especially to prevent encroachment from outsiders (Castilla and Gelcich 2008). Simple institutional structures with clear lines of responsibility are important for successful fisheries management (Hilborn et al. 2005). To build confidence, transparency is important; public annual reports on the status of the fisheries managed can be helpful.

Box 7.8. Reduction of Subsidies and Capacity Reduction

Co-management systems engaging multiple stakeholders have been developed in a wide range of fisheries in LAC. A variety of harmful subsidies and overcapacity in fisheries both serve to distort incentives. Addressing these issues should be integral to any incentives-based approach to fisheries management.

Many fisheries in LAC are heavily subsidized (Figures 2.1.1, 2.1.2; Khan et al. 2006). Some subsidies, such as tax exemption on fuel or access to low-interest credit for fleet development, create perverse incentives that directly contribute to overfishing and development of overcapacity (Seijo 2009). Reducing such perverse subsidies is an essential step to re-aligning private incentives with national economic interests. While subsidy reduction is often unpopular, opposition can be mitigated by reorienting subsidies toward investment in responsible fisheries management, including efforts to reduce IUU fishing (especially by foreign fleets).

When a fishery is characterized by fleet overcapacity, capacity reduction may be achieved directly through licensing or vessel buyback schemes, or indirectly through the creation of secure use rights that stimulate fleet reduction. However, vessel buyback programs have been less effective than expected. Often, only the least efficient vessels are removed from the fishery thus increasing the overall efficiency of the remaining fleet, and the programs do not address the underlying incentives that led to fleet overcapacity in the first place (Beddington et al. 2007).

Catch shares and territorial use rights (TURFs) encourage fishers to adjust capacity to optimize economic yield (assuming no distortion by inappropriate subsidies) (Beddington et al. 2007; Grafton et al. 2006). ITQs can provide compensation to those who choose to leave the industry, stimulating fleet reduction without recourse to public funds (Hilborn 2007d). For example, introduction of catch shares in the majority of Chilean fisheries has led to a major reduction in fishing capacity in these fisheries, without recourse to costly decommissioning programs (OECD 2009).

Box 7.9. Small-scale Fisheries

Globally, there is growing consensus on the strategies and tools required to manage high-value industrial fisheries, but managing small-scale fisheries presents distinct challenges (Salas et al. 2007; Gelcich et al. 2009). For instance, output controls may be the best option for single species industrial fisheries with a limited number of vessels and ports, but may not be feasible for small-scale fisheries that involve numerous vessels operating out of many ports and targeting multiple species (Salas et al. 2007). In LAC, many small-scale fisheries are effectively open access, leading to overexploitation and livelihood decline. Simple input and output controls, such as gear restrictions, closed seasons, and size limits, are commonly used because they are easier to monitor than aggregate catches, especially for multi-species fisheries. Catch quota systems are undermined by unreliable estimates of stock sizes, high rates of IUU fishing, and the high cost of surveillance and control in a mobile, spatially-dispersed fishery (Salas et al. 2007). Marine reserves are often used to protect species of concern and/or valued habitats, but they are not effective to reduce fishing effort overall. Fisheries refugia, to protect spawning aggregations and recruitment, may help sustain productivity (Appeldoorn 2008). Approaches based on defining fishing rights and increased co-management are more promising, where feasible.

The challenges of sustainably managing small-scale fisheries of mobile species need greater attention. LAC has pioneered development of approaches to manage sedentary and spatially-structured resources in small-scale fisheries (Orensanz et al. 2005), but tools to manage small-scale fisheries of more mobile resources remain elusive. Orensanz et al. (2005) emphasize that no method is a panacea; appropriate strategies and tools need to be designed for each context. Recent research on socio-ecological systems has highlighted the need to engage local stakeholders in developing socially and culturally appropriate solutions instead of imposing generic ones from the top down (McClanahan et al. 2009).

in place to prevent the build-up of capacity and effort in alternative fisheries (such as effective access controls).

There have also been concerns about equity in catch share systems, in that these shares represent real wealth and economic opportunities from which others are excluded. The system for assigning shares should be developed with transparency and stakeholder involvement from the beginning. A particular concern is the removal of the social safety net provided by open access fisheries. This can be mitigated through community rather individual use rights where appropriate (as in most TURF systems)

Dedicated access privileges are designed to promote sustainable fisheries management. They do not deal directly with ecosystem issues such as by-catch and habitat damage (Beddington et al. 2007), though reducing fishing effort and stopping the race to fish may diminish these impacts (Branch 2009; Essington 2010). Other tools may be needed to deal with these problems (Hilborn 2007).

CERTIFICATION AND MARKET INCENTIVES

Certification schemes can provide incentives for SEM by granting privileged access to high-value markets and enabling fishers to differentiate their product in return for commitment to responsible fisheries management and reduced ecosystem impact. Two fisheries in the LAC region have been certified by the Marine Stewardship Council (MSC): Patagonia Scallop (Argentina) and Baja California red rock lobster (Mexico). Both fisheries are limited in size, which provides clear incentives and facilitates surveillance and control. Fisheries being assessed for certification include the Sian Ka'an and Banco Chinchorro Biosphere Reserves spiny lobster (Mexico), the Gulf of California sardine (Mexico), and the Suriname Atlantic seabob shrimp.

The Patagonia scallop fishery provides an example of a fishery that has been managed to avoid excess fishing effort and overcapitaliza-

Box 7.10. Reduction of Discards, Bycatch, and Waste

Discards here comprise individuals of targeted species that are rejected, bycatch (non-targeted species, including some of commercial value to other fisheries), and ghost-fishing. Discarding may be exacerbated by regulations such as size restrictions or quotas that encourage high-grading (Hall and Mainprize 2005). Discard reduction can be achieved through regulatory tools (such as gear specifications or area management (e.g., permanently or temporarily closing areas with unacceptably high discard rates), or incentive-based approaches (bycatch quotas, certification).

All gears can produce discards, but some are more selective than others. Input controls have been used to increase the selectivity of fishing gear (e.g., minimum mesh size to reduce pressure on juveniles) and reduce habitat damage (e.g., low-impact trawls instead of destructive gear). Gear can be made more selective with bycatch reduction devices and other measures (Hall and Mainprize 2005). Closed areas and seasons can be effective in reducing negative impacts during spawning and other sensitive periods (Salas et al. 2007). For instance, the Peruvian anchoveta fishery may be closed in specific areas if the proportion of juveniles in the catch is unacceptably high. Discard rates may also be reduced through initiatives to increase use of non-targeted species (Kelleher 2005).

Incentive-based approaches include adjusting catch shares to favor vessels with low discard rates, penalties on vessels for discards, and fleet-wide discard reduction quotas. Estimates of fishing mortality in stock assessments should include mortality from all sources, not just targeted fisheries (Crowder and Murawski 1998). Access to high value international markets (for example, through certification) may also be dependent on reducing discards and provide significant incentives. These approaches can provide strong incentives to avoid high bycatch areas and stimulate technological innovation by fishers seeking to reduce bycatch cost-effectively (Hilborn 2007d; Branch 2009). Such measures require adequate surveillance and control systems, perhaps even comprehensive observer coverage; thus, these measures may be costly. Catch share systems can also reduce discards by lowering the pressure to fish as fast as possible and reducing ghost fishing due to lost gear (Hilborn 2007d; Branch 2009).

Solutions need to be technically feasible, financially and economically viable, and enforceable. Participatory research can play an important role in developing such solutions (e.g., Peckham et al. 2007). Incentives-based approaches generally require onboard observers and are, therein, often expensive to implement (Hilborn 2004). A major concern is that tighter regulations on one fishery may displace the problem to fisheries elsewhere with less strict enforcement.

Box 7.11. Fisheries Refugia to Safeguard Critical Life Stages and Essential Fish Habitat

Discards here comprise individuals of targeted species that are rejected, bycatch (non-targeted species, including some of comZoning is used to balance multiple objectives in marine ecosystems and reduce conflict between multiple users (Rivera-Arriaga 2005). Often a feature of integrated coastal zone management (Suman, 2002; Rivera-Arriaga 2005; Edwards, 2009), zoning may also be extended beyond the continental shelf to manage the broader EEZ. Marine protected areas (MPAs), including no-take marine reserves, are one form of spatial zoning that can contribute to SEM.

Marine reserves are sometimes adopted to control exploitation rates. However, they do not reduce fishing effort per se, but shift fishing effort to other areas (Hilborn et al. 2004). In the absence of complementary measures, marine reserves may simply result in more intense fishing outside their boundaries. Conventional measures may provide a more direct tool for reducing fishing effort (Beddington et al. 2007).

Marine reserves have a greater role to play in managing multi-species fisheries, when conventional approaches will lead to some stocks being overfished at multispecies MSY, and in small-scale fisheries where management by output controls is more challenging (Salas et al. 2007). In these cases, marine reserves can protect stocks in specific sites against overexploitation. The contribution to fisheries management will depend on the location and size of the marine reserve in relation to the spatial structure and mobility of the stock. For spatially structured stocks, rotation of closed areas has proven successful in Chile (Castilla et al. 1998; Castilla and Fernandez 1998). As in terrestrial systems, the success of conservation inside marine reserves is often dependent on how resources are managed outside reserves. Marine reserves may not rescue stocks that are poorly managed in the rest of their range.

Fisheries refugia are marine reserves designed to protect habitat essential to critical life history stages of targeted populations (e.g., spawning and recruitment areas). For fisheries that suffer from recruitment overfishing, fisheries refugia may increase recruitment and yields within a fishing area if they protect critical life stages or habitats, such as spawning aggregations or nurseries. Refugia effectiveness will depend, in part, on the mobility of species. For example, in Chile, marine reserves are reproductive refuges, designed as a tool for fisheries management. They are distinct from MPAs, designed to protect biodiversity for conservation or research (Orensanz et al. 2005). For each fishery, known spawning and nursery grounds should be identified as part of the management planning process. Sites key to productivity may then be protected to reduce interference with recruitment or growth. Measures may include restricting gear, methods, seasons, and access or use rights. The location and size of refugia or networks of them are critical to success, especially in the context of populations with source-sink configurations (Sale et al. 2005; Seijo and Caddy 2008). Adaptive management approaches may help address the challenges associated with refugia design (Sale et al. 2005).

In some cases, area management may be easier to enforce than other regulations. Area closures are facilitated by the growing use of vessel monitoring systems (VMS) in LAC. For example, all vessels with catch shares in the Peruvian anchoveta fishery, including the artisanal fleet, are required to have VMS.

tion. Two companies have harvesting authorization for the Patagonian scallop, operating a total of four freezer-trawlers and landing approximately 50,000t. Trawling is restricted to areas known to be primarily sand and mud. Size regulations are designed to ensure that individuals are not harvested until after they have already spawned three times. The fishery benefits from 100% observer coverage. One of the companies emphasizes that MSC certification has differentiated their product from the competition and opened access to high-value markets in Europe (MSC 2009).

The Baja California red rock lobster was certified sustainable in April 2004. At the time of writing, the 5-year certificate has expired and the fishery is being re-assessed. The fishery involves nine cooperatives, each fishing an exclusive area under a long-term concession. A biologist for the cooperatives argued that even though 95% of the

lobster is currently sold to Asia without the MSC label, demand for MSC products is expected to increase and the label will eventually become essential for accessing markets (MSC 2009).

7.13 MANAGEMENT CAPACITY, FUNDING, AND RESEARCH FOR SEM

Management Capacity

SEM requires management capability to design, evaluate, and adapt science-based strategies, rationalize the incentives framework, and

ensure effective surveillance and control. Investment in an appropriate institutional structure to pursue these ends is fundamental.

Effective Surveillance and Control

IUU fishing is a major factor in overfishing. It occurs when strategies and regulations are weak or not effectively enforced (Beddington et al. 2007). Surveillance and control is vital to incentive-based management as well as to traditional regulation. The efficacy of catch shares depends on it, for example. In Chile's black hake ITQ, the TAC increased from 5,000t to 7,500t in the first four years, but then declined to 6,000t in the fifth year. Illegal fishing has been blamed for a downturn in the stock, with IUU harvest estimated as equal to the legal one (Bernal et al. 1999). Catch shares do not in themselves remove the incentive to cheat and can increase incentives to underreport, as seen in the Peruvian anchoveta case. The fact that cheating reduces the value of other fishers' quotas has in some cases stimulated fishers to invest in surveillance and enforcement themselves, as in several Chilean TURF fisheries (Defeo and Castilla 2005). But fishers and their associations may need support from government agencies (Castilla and Gelcich 2008), especially against powerful outside interests. Surveillance and control systems need to be agreed and in place prior to starting ITQs (Branch 2009).

Design of fisheries regulation and incentives systems needs to consider the feasibility of surveillance and control. Input measures like restrictions on vessel numbers or on fishing seasons may be easier to enforce than output measures, such as catch quotas (Beddington et al. 2007). Fishers will be deterred from breaking fishing regulations if the loss expected from detection and successful prosecution exceeds the expected gain (Beddington et al. 2007). Enforcement failure may be attributed to low detection and conviction rates, and/or inadequate penalties in relation to expected rewards. Countries impacted by IUU fishing need to strengthen governance (Agnew et al. 2009), by investing in capacity to undertake surveillance and enforcement, improved procedures to prosecute IUU fishing, and stronger sanctions.

Estimates of unreported catches need to be included in stock assessment models and taken into account when setting the TAC. Otherwise, unreported catches over and above the TAC will lead to stock depletion. This creates a strong incentive to control IUU fishing. Addressing IUU fishing is needed under SEM to ensure that registered fishers have a stake in improved fisheries management.

Funding: Financing the Costs of Transition to SEM

In principle, moving toward SEM should bring an increase in the economic rent captured from fisheries. The additional long-term costs of fisheries development under SEM can be financed by reorienting

funds that support harmful subsidies toward the support of critical facets such as strengthened surveillance and control, and by capturing part of the increased economic rent through taxes or license fees, or via other cost recovery mechanisms. Funding sources for management plans should be identified before launching them.

In Chile, the national treasury captured value at the start of the new ITQ systems by auctioning quotas, with subsequent annual re-auctioning of 10% of the total quota. AMERBs must also pay an annual fee in return for territorial use rights (Castilla and Gelcich 2008). License fees account for only 5% of the public income generated by these fisheries (Cerdeira-D'Amico and Urbina-Veliz 2000), in contrast to the pattern in many fisheries worldwide, where license fees are the main way costs are recovered. Chilean fisheries have been able to absorb these costs due to a combination of higher catches, greater efficiency, smaller fleets, and the elimination of overcapitalization, all increasing realized value (Gomez-Lobo et al. 2007). The Peruvian anchoveta case also shows that increased returns on investment can be generated by SEM. Two new levies have been designed so that beneficiaries of the reform fund the social costs of transition.

Many countries in LAC do not attempt to recover fisheries management costs from the industry; in at least some cases, this may amount to a perverse subsidy. However, in some instances, the industry has covered some of the costs of transition to or management under SEM, based on expectations of increased returns on investment. Pena-Torres (2002) discusses ITQ fisheries in which surveillance and control are funded wholly or in part by the industry, and suggests such an approach for Chile. The contribution of the fishery to the national treasury will increase via corporate income tax revenues, even without restructuring the tax and cost recovery regime. Making SEM in fisheries self-financing should be encouraged.

In Chile, fisheries associations cover the costs of baseline studies and annual stock assessments for AMERBs. They also take responsibility for surveillance and control within their own organizations, thus reducing the costs of enforcement incurred by public agencies (Castilla and Gelcich 2008). Cost recovery is more likely to be achieved where fishers have incentives to engage constructively in fisheries management (Beddington et al. 2007).

Research to Support SEM

In many LAC countries, fishery research institutes have limited capacity (Salas et al. 2007), due to shortage of trained personnel, insufficient financial support to gather fisheries-independent data and carry out operational research programs, and lack of a clear mandate to lead toward improved fisheries.

To attain responsible fisheries management in the context of the pervasive uncertainty inherent in fisheries, much greater capacity

for risk assessment, decision analysis, and strategy evaluation is required.

To support progress toward SEM, essential fish habitats need to be identified and mapped as a basis for establishing fisheries refugia. Further research is also required to assess the ecosystem effects of fishing; marine reserves may play a useful role as control sites. The results of ecological risk assessment can help identify priorities for the study of fishing pressures on ecosystems..

Ecosystem models (such as Ecopath with Ecosim, and Atlantis) provide a framework for exploring the ecosystem impacts of alternative fisheries management options. A range of ecosystem models are

available (Plagányi 2007). It will probably be sensible to start with relatively simple models that focus on key interactions rather than full ecosystem models. In the early stages, these models should be considered exploratory – they will help to identify important interactions, provide new insights into the ecosystem effects of fishing, and guide further empirical research, but some time is required before ecosystem models can be used as predictive management tools. The data demands of multispecies ecosystem models are substantial (Beddington et al. 2007; Seijo 2007). The wide range of possible relationships for key functional responses such as those between predators and prey generates a great deal of uncertainty in model output. An incremental exploratory approach, starting with relatively few ecosystem elements and then building on this, offers a way forward.

Appendices

Appendix 7.1. General principles of the FAO Code of Conduct for Responsible Fisheries

6.1 States and users of living aquatic resources should conserve aquatic ecosystems. The right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources.

6.2 Fisheries management should promote the maintenance of the quality, diversity and availability of fishery resources in sufficient quantities for present and future generations in the context of food security, poverty alleviation and sustainable development. Management measures should not only ensure the conservation of target species but also of species belonging to the same ecosystem or associated with or dependent upon the target species.

6.3 States should prevent overfishing and excess fishing capacity and should implement management measures to ensure that fishing effort is commensurate with the productive capacity of the fishery resources and their sustainable utilization. States should take measures to rehabilitate populations as far as possible and when appropriate.

6.4 Conservation and management decisions for fisheries should be based on the best scientific evidence available, also taking into account traditional knowledge of the resources and their habitat, as well as relevant environmental, economic and social factors. States should assign priority to undertake research and data collection in order to improve scientific and technical knowledge of fisheries including their interaction with the ecosystem. In recognizing the transboundary nature of many aquatic ecosystems, States should encourage bilateral and multilateral cooperation in research, as appropriate.

6.5 States and subregional and regional fisheries management organizations should apply a precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment, taking account of the best scientific evidence available. The absence of adequate scientific information should not be used as a reason for postponing or failing to take measures to conserve target species, associated or dependent species and non-target species and their environment.

6.6 Selective and environmentally safe fishing gear and practices should be further developed and applied, to the extent practicable, in order to maintain biodiversity and to conserve the population structure and aquatic ecosystems and protect fish quality. Where proper selective and environmentally safe fishing gear and practices exist, they should be recognized and accorded a priority in establishing conservation and management measures for fisheries. States and users of aquatic ecosystems should minimize waste, catch of non-target species, both fish and non-fish species, and impacts on associated or dependent species.

6.7 The harvesting, handling, processing and distribution of fish and fishery products should be carried out in a manner which will maintain the nutritional value, quality and safety of the products, reduce waste and minimize negative impacts on the environment.

6.8 All critical fisheries habitats in marine and fresh water ecosystems, such as wetlands, mangroves, reefs, lagoons, nursery and spawning areas, should be protected and rehabilitated as far as possible and where necessary. Particular effort should be made to protect such habitats from destruction, degradation, pollution and other significant impacts resulting from human activities that threaten the health and viability of the fishery resources.

6.9 States should ensure that their fisheries interests, including the need for conservation of the resources, are taken into account in the multiple uses of the coastal zone and are integrated into coastal area management, planning and development.

6.10 Within their respective competences and in accordance with international law, including within the framework of subregional or regional fisheries conservation and management organizations or arrangements, States should ensure compliance with and enforcement of conservation and management measures and establish effective mechanisms, as appropriate, to monitor and control the activities of fishing vessels and fishing support vessels.

6.11 States authorizing fishing and fishing support vessels to fly their flags should exercise effective control over those vessels so as to ensure the proper application of this Code. They should ensure that the activities of such vessels do not undermine the effectiveness of conservation and management measures taken in accordance with international law and adopted at the national, subregional, regional or global levels. States should also ensure that vessels flying their flags fulfil their obligations concerning the collection and provision of data relating to their fishing activities.

6.12 States should, within their respective competences and in accordance with international law, cooperate at subregional, regional and global levels through fisheries management organizations, other international agreements or other arrangements to promote conservation and management, ensure responsible fishing and ensure conservation and protection of living aquatic resources throughout their range of distribution, taking into account the need for compatible measures in areas within and beyond national jurisdiction.

6.13 States should, to the extent permitted by national laws and regulations, ensure that decision making processes are transparent and achieve timely solutions to urgent matters. States, in accordance with appropriate procedures, should facilitate consultation and the effective participation of industry, fishworkers, environmental and other interested organizations in decision making with respect to the development of laws and policies related to fisheries management, development, international lending and aid.

6.14 International trade in fish and fishery products should be conducted in accordance with the principles, rights and obligations established in the World Trade Organization (WTO) Agreement and other relevant international agreements. States should ensure that their policies, programmes and practices related to trade in fish and fishery products do not result in obstacles to this trade, environmental degradation or negative social, including nutritional, impacts.

6.15 States should cooperate in order to prevent disputes. All disputes relating to fishing activities and practices should be resolved in a timely, peaceful and cooperative manner, in accordance with applicable international agreements or as may otherwise be agreed between the parties. Pending settlement of a dispute, the States concerned should make every effort to enter into provisional arrangements of a practical nature which should be without prejudice to the final outcome of any dispute settlement procedure.

6.16 States, recognising the paramount importance to fishers and fishfarmers of understanding the conservation and management of the fishery resources on which they depend, should promote awareness of responsible fisheries through education and training. They should ensure that fishers and fishfarmers are involved in the policy formulation and implementation process, also with a view to facilitating the implementation of the Code.

Appendix 7.2. Case Studies on the Contribution of Aquatic Ecosystem Services to Fisheries, Tourism, and Other Sectors

COUNTRY (REGION)	MARINE/ FRESHWATER	ECOSYSTEM(S)	SECTOR(S)	USES COST- BENEFIT ANALYSIS APPROACH?	REFERENCE(S)
ARGENTINA	MARINE	SEVERAL COASTAL HABITATS	FISHERIES	NO	UNEP 2002
ARGENTINA (SAN JOSÉ GULF)	MARINE	DIVING FISHERY	FISHERIES	YES	ORENSANZ ET AL. 2007
BELIZE (GLADDEN SPIT AND SILK CAYES MARINE RESERVE)	MARINE	CORAL REEF, MPA, WHALE SHARK	TOURISM	YES	HARGREAVES-ALLEN 2009
BELIZE, HONDURAS, MEXICO (MESOAMERICAN REEF)	MARINE	CORAL REEF, MPA	FISHERIES	YES	TALBOT AND WILKINSON 2001
BRAZIL (PANTANAL)	FRESHWATER	WETLAND	TOURISM, FISHERIES	NO	SHRESTHA, SEIDLE, AND MORAES 2002
CARIBBEAN SEA	MARINE	MPA	TOURISM	NO	GREEN AND DONNELLY 2003
CARIBBEAN SEA	MARINE	CORAL REEF	FISHERIES, TOURISM, COASTAL PROTECTION	YES	CESAR, BURKE, AND PET-SOEDE 2003; BURKE AND MAIDENS 2004
CARIBBEAN SEA	MARINE	CORAL REEF	TOURISM, FISHERIES, COASTAL PROTECTION	YES	BURKE AND MAIDENS 2004
CHILE	MARINE	SEA URCHIN FISHERY	FISHERIES	YES	MORENO ET AL. 2007
COSTA RICA (TERRABA-SIERPE WETLANDS)	MARINE	WETLAND, MANGROVE	FISHERIES	NO	REYES ET AL. 2004
COSTA RICA (TORTUGUERO NATIONAL PARK)	MARINE	SEA TURTLE	FISHERIES, TOURISM	YES	TROËNG AND DREWS 2004
COSTA RICA, CUBA, MEXICO, BRAZIL	MARINE	BEACH, SEA TURTLE	FISHERIES, TOURISM	YES	TROËNG AND DREWS 2004
ECUADOR (GALAPAGOS ISLANDS)	MARINE	MPA	TOURISM, FISHERIES	YES	WILEN, STEWART, AND LAYTON 2000
EL SALVADOR (GULF OF FONSECA)	MARINE	MANGROVE	AQUACULTURE, FISHERIES	YES	GAMMAGE 1997
JAMAICA (MONTEGO BAY)	MARINE	GENETIC/MEDICINAL RESOURCES, BIODIVERSITY, MPA	PHARMACEUTICAL, TOURISM, FISHERIES, COASTAL PROTECTION	YES	CESAR, ÖHMAN, ESPEUT, AND HONKANEN 2000; GUSTAVSON 1998; RUITENBEEK AND CARTIER 2001
LATIN AMERICA AND THE CARIBBEAN SEA	MARINE	RESILIENCE	FISHERIES	YES	CHAPMAN ET AL. 2008
MEXICO (GULF OF CALIFORNIA)	MARINE	SEVERAL COASTAL HABITATS	FISHERIES	YES	EZCURRA ET AL. 2009
MEXICO (GULF OF CALIFORNIA)	MARINE	DEEP SEA, WHALE SHARK	TOURISM	YES	LOW-PFENG, DE LA CUEVA, AND ENRÍQUEZ 2005
MEXICO (GULF OF CALIFORNIA)	MARINE	MANGROVE	FISHERIES	YES	ABURTO-OROPEZA ET AL. 2008
MEXICO (PACIFIC COAST)	MARINE	MANGROVE	FISHERIES	YES	SANJURJO, CADENA, AND ERBSTOESSER 2005
MEXICO (SONORA)	FRESHWATER	STREAM	WATER MANAGEMENT	YES	OJEDA, MAYER & SOLOMON 2008
PANAMA (COIBA NATIONAL PARK)	MARINE	MANGROVE, MPA	FISHERIES, TOURISM	YES	MONTENEGRO 2007
PANAMA (PACIFIC COAST)	MARINE	MANGROVE	FISHERIES	YES	TALBOT AND WILKINSON 2001
TRINIDAD AND TOBAGO, ST. LUCIA	MARINE	CORAL REEF	TOURISM, FISHERIES	YES	BURKE ET AL. 2008
TURKS AND CAICOS ISLANDS	MARINE	CORAL REEF	TOURISM, FISHERIES, COASTAL PROTECTION	NO	CARLETON AND LAWRENCE 2005
VENEZUELA (MORROCOY NATIONAL PARK)	MARINE	MANGROVE; MPA	FISHERIES, TOURISM	YES	CARTAYA FEBRES AND PABON-ZAMORA 2009

Appendix 7.3. Size of the Fisheries Sector (Contribution to GDP), Size of National Economy (GDP), and % Contribution of Fisheries to GDP

FAO FISHERIES PROFILE			
COUNTRY	FISHERIES (\$)	OVERALL GDP (\$)	FISHERIES SECTOR/GDP (%)
ANTIGUA AND BARBUDA	13,300,000	1,000,000,000	1.33
BAHAMAS	173,375	6,935,0001	2.50
ARGENTINA	192,000,000	151,298,000,000	0.13
BARBADOS	26,000,000	2,600,000,000	1.00
BELIZE	49,050,000	986,500,000	4.97
BOLIVIA	7,510,000	8,100,000,000	0.09
BRAZIL	2,382,000,000	595,500,000,000	0.40
CHILE	5,422,656,000	169,458,000,0001	3.20
COLOMBIA	3,172,920,000	82,200,000,000	3.86
COSTA RICA	53,810,000	16,818,000,000	0.32
CUBA		27,686,000,000	0.00
DOMINICA		266,670,000	0.00
DOMINICAN REPUBLIC	3,060	30,600,000	0.01
ECUADOR	1,055,195	16,749,124	6.30
EL SALVADOR		14,950,000	0.00
GRENADE	13,000,000	520,000,000	2.50
GUATEMALA	8,276	27,589,000	0.03
GUYANA	157,000,0002	5,587,000,000	2.81
HAITI		29,000,000,000	0.00
HONDURAS		5,900,000,000	0.00
JAMAICA	4,084,000	1,021,000,000	0.40
MEXICO	4,991,200,000	623,900,000,000	0.80
NICARAGUA	48,400,000	4,900,000,000	0.99
PANAMA	342,000,000	17,100,000,000	2.00
PARAGUAY		15,977,0001	0.00
PERU	112,377,500	5,690,000,000	1.98
ST. KITTS AND NEVIS	3,800,000	453,000,000	0.84
ST. LUCIA		825,000,000	0.00
ST. VINCENT AND THE GRENADINES	4,980,000	249,000,000	2.00
SURINAME		1,600,000,000	0.00
TRINIDAD AND TOBAGO	13,320,000	14,800,000,000	0.09
URUGUAY	41,360,840	9,618,800,000	0.43
VENEZUELA	427,000,000	85,400,000,000	0.50

Sources: Fishery and Aquaculture Country Profiles <http://www.fao.org/fishery/countryprofiles/search/en>

1. Data from World Bank 2008

2. In Guyanese dollars

3. Includes aquaculture

<http://www.caricom-fisheries.com/> Catarci, C. (2004) World Markets and Industry of Selected Commercially-Exploited Aquatic Species with an International Conservation Profile. FAO Fisheries Circular No. 990

Tietze, U.; Haughton, M.; Siar, S.V. (eds.) Socio-economic indicators in integrated coastal zone and community-based fisheries management – Case studies from the Caribbean.

FAO Fisheries Technical Paper. No. 491. Rome. FAO. 2006. 208p.

Appendix 7.4: Employment in Primary, Secondary, Tertiary Sectors, and in Small Scale Fisheries

	PRIMARY ¹	SECONDARY ¹	TERTIARY ¹	TOTAL PRIMARY AND SECONDARY ¹	OVERALL EMPLOYMENT ²	FISHERIES AS % OF OVERALL EMPLOYMENT	SMALL-SCALE FISHERIES ³
ANTIGUA AND BARBUDA	864	50	0	914	28,000	3.26	1,088
ARGENTINA	0	100,000 ⁴	0	100,000	9,639,000	1.04	1,690
BAHAMAS	9,300	0	0	9,300	161,000	5.78	
BARBADOS	2,000	825	0	2,825	132,000	2.14	2,200
BELIZE	1,672	123	0	1,795	78,000	2.30	
BOLIVIA	3,600	19,560	2,000	23,160	2,091,000	1.11	
BRAZIL	790,000	250,000	4,000,000	1,040,000	84,596,000	1.23	553,872
CHILE	77,928	80,424	0	158,352	5,905,000	2.68	27,876
COLOMBIA	66,000	28,485	26,700	94,485	18,217,000	0.52	26,000
COSTA RICA	8,567	19,033	6,000	27,600	1,777,000	1.55	4,000
CUBA	11,890	4,820	18,930	16,710	4,642,000	0.36	
DOMINICA	2,843	60	0	2,903	26,000	11.17	3,985
DOMINICAN REPUBLIC	11,138	17,707	0	28,845	3,315,000	0.87	
ECUADOR	95,200	24,800	0	120,000	3,892,000	3.08	82,000
EL SALVADOR	26,260	0	0	26,260	2,526,000	1.04	13,000
GRENADA	2,400	400	0	2,800	35,000	8.00	1,931
GUATEMALA	32,320	9,500	0	41,820	4,769,000	0.88	10,269
GUYANA	6,500	6,000	0	12,500	240,000	5.21	5,644
HONDURAS	36,008	47,686	0	83,694	2,544,000	3.29	11,700
JAMAICA	20,000	480	0	20,480	1,063,000	1.93	20,000
MEXICO	247,765	20,962	0	268,727	41,321,000	0.65	138,941
NICARAGUA	33,840	1,546	0	35,386	1,953,000	1.81	13,439
PANAMA	1,500	37,500	0	39,000	1,188,000	3.28	13,062
PARAGUAY	7,064	8,000	1,200	15,064	2,247,000	0.67	
PERU	80,000	45,000	0	125,000	34,000,000	0.37	56,800
ST. LUCIA	2,319	120	40	2,439	59,000	4.13	2,059
ST. VINCENT AND THE GRENADINES	2,500	500	0	3,000	35,000	8.57	2,500
SURINAME	4,420	2,759	10	7,179	73,000	9.83	
TRINIDAD AND TOBAGO	5,100	1,225	760	6,325	525,000	1.20	2,146
URUGUAY	3,000	3,200	0	6,200	1,115,000	0.56	1,400
VENEZUELA	44,302	0	0	44,302	9,994,000	0.44	40,000
TOTAL	1,636,300	730,765		2,367,065	238,186,000	0.99	1,035,602

Sources:

1. Fishery and Aquaculture Country Profiles 2008
2. 2007/2008 Human Development Report (data 1996-2005)
3. Chuenpagdee et al. 2006
4. Onestini and Gutman 2002

Appendix 7.5. Status of Fisheries in LAC

COMMON NAME	SCIENTIFIC NAME	STATUS OF EXPLOITATION	FAO STATISTICAL AREA	SOURCE	REFERENCE(S)
1.	PACIFIC ANCHOVETA	CETENGAULIS MYSTICETUS	FULLY EXPLOITED	EASTERN CENTRAL PACIFIC	CSIRKE AND TANSDTAD 2005
2.	JAMAICA WEAKFISH	CYNOSCION JAMAICENSIS	OVEREXPLOITED§	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
3.	SOUTH AMERICAN STRIPED WEAKFISH	CYNOSCION STRIATUS	FULLY TO OVEREXPLOITED	SOUTHWEST ATLANTIC	CSIRKE 2005
4.	GREEN WEAKFISH	CYNOSCION VIRESCENS	OVEREXPLOITED§	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
5.	PATAGONIAN TOOTHFISH	DISSOSTICHUS ELEGINOIDES	MODERATELY TO FULLY EXPLOITED	SOUTHWEST ATLANTIC	CSIRKE 2005
6.	PATAGONIAN TOOTHFISH	DISSOSTICHUS ELEGINOIDES	MODERATELY EXPLOITED	SOUTHEAST PACIFIC	CSIRKE 2005
7.	JUMBO FLYING SQUID	DOSIDICUS GIGAS	MODERATELY EXPLOITED	SOUTHEAST PACIFIC	CSIRKE 2005
8.	JUMBO FLYING SQUID	DOSIDICUS GIGAS	MODERATELY TO FULLY EXPLOITED	EASTERN CENTRAL PACIFIC	CSIRKE AND TANSDTAD 2005
9.	ARGENTINE ANCHOITA	ENGAULIS ANCHOITA	UNDEREXPLOITED	SOUTHWEST ATLANTIC	CSIRKE 2005
10.	CALIFORNIAN ANCHOVY	ENGAULIS MORDAX	DEPLETED	EASTERN CENTRAL PACIFIC	CSIRKE AND TANSDTAD 2005
11.	PERUVIAN ANCHOVETA	ENGAULIS RINGENS	FULLY TO OVEREXPLOITED	SOUTHEAST PACIFIC	FAO 2009
12.	GOLIATH GROUPER	EPINEPHELUS ITAJARA	RECOVERING	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
13.	RED GROUPER	EPINEPHELUS MORIO	OVEREXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
14.	NASSAU GROUPER	EPINEPHELUS STRIATUS	RECOVERING	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
15.	SOUTHERN PINK SHRIMP	FARFANTEPENAEUS DUORARUM	MODERATELY TO FULLY EXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
16.	SOUTHERN BROWN SHRIMP	FARFANTEPENAEUS SUBTILIS	FULLY EXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
17.	PINK CUSK-EEL	GENYPTERUS BLACODES	MODERATELY TO FULLY EXPLOITED	SOUTHWEST ATLANTIC	CSIRKE 2005
18.	ROYAL RED SHRIMP	HYMENOPENAEUS ROBUSTUS	MODERATELY TO FULLY EXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
19.	WESTERN ATLANTIC SAILFISH	ISTIOPHORUS PLATYPTERUS	MODERATELY EXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
20.	NORTHERN WHITE SHRIMP	LITOPENAEUS SETIFERUS	MODERATELY TO FULLY EXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
21.	OPALESCENT SQUID	LOGILO OPALESCENS	MODERATELY TO FULLY EXPLOITED	EASTERN CENTRAL PACIFIC	CSIRKE AND TANSDTAD 2005
22.	RED SNAPPER	LUTJANUS CAMPECHANUS	RECOVERING	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
23.	KING WEAKFISH	MACRODON ANCYLONON	OVEREXPLOITED§	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
24.	PATAGONIAN GRENADIER	MACRURONUS MAGELLANICUS	MODERATELY EXPLOITED	SOUTHWEST ATLANTIC	CSIRKE 2005
25.	PATAGONIAN GRENADIER	MACRURONUS MAGELLANICUS	FULLY TO OVEREXPLOITED	SOUTHEAST PACIFIC	CSIRKE 2005
26.	ATLANTIC BLUE MARLIN	MAKAIRA NIGRICANS	OVEREXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
27.	SOUTHERN HAKE	MERLUCCIIUS AUSTRALIS	FULLY TO OVEREXPLOITED*	SOUTHEAST PACIFIC	CSIRKE 2005

Appendix 7.5. Status of Fisheries in LAC (continued)

COMMON NAME	SCIENTIFIC NAME	STATUS OF EXPLOITATION	FAO STATISTICAL AREA	SOURCE	REFERENCE(S)
28.	SOUTHERN HAKE	MERLUCCIIUS AUSTRALIS	FULLY EXPLOITED	SOUTHWEST ATLANTIC	CSIRKE 2005
29.	SOUTH PACIFIC HAKE	MERLUCCIIUS GAYI GAYI	FULLY TO OVEREXPLOITED*	SOUTHEAST PACIFIC	CSIRKE 2005
30.	ARGENTINEAN HAKE	MERLUCCIIUS HUBBSI	OVEREXPLOITED	SOUTHWEST ATLANTIC	CSIRKE 2005
31.	SOUTHERN BLUE WHITING	MICROMESISTIUS AUSTRALIS	OVEREXPLOITED	SOUTHWEST ATLANTIC	CSIRKE 2005
32.	WHITEMOUTH CROACKER	MICROPOGONIAS FURNIERI	MODERATELY TO FULLY EXPLOITED	SOUTHWEST ATLANTIC	CSIRKE 2005
33.	WHITEMOUTH CROACKER	MICROPOGONIAS FURNIERI	OVEREXPLOITED§	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
34.	SMALLEYE CROAKER	NEBRIS MICROPS	OVEREXPLOITED§	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
35.	MEXICAN FOUR-EYED OCTOPUS	OCTOPUS MAYA	OVEREXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
36.	PACIFIC THREAD HERRING	OPISTHONEMA LIBERTATE	FULLY EXPLOITED	SOUTHEAST PACIFIC	CSIRKE 2005
37.	ARGENTINE RED SHRIMP	PLEOTICUS MUELLERI	FULLY EXPLOITED	SOUTHWEST ATLANTIC	CSIRKE 2005
38.	EASTERN PACIFIC BONITO	SARDA CHILIENSIS	DEPLETED	SOUTHEAST PACIFIC	CSIRKE 2005
39.	BRAZILIAN SARDINELLA	SARDINELLA BRASILIENSIS	OVEREXPLOITED	SOUTHWEST ATLANTIC	CSIRKE 2005
40.	SOUTH AMERICAN SARDINE	SARDINOPS SAGAX.	DEPLETED	SOUTHEAST PACIFIC	CSIRKE 2005
41.	RED DRUM	SCIAENOPS OCELLATUS	RECOVERING	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
42.	CHUB MACKEREL	SCOMBER JAPONICUS	MODERATELY EXPLOITED	SOUTHEAST PACIFIC	CSIRKE 2005
43.	CHUB MACKEREL	SCOMBER JAPONICUS	RECOVERING	EASTERN CENTRAL PACIFIC	CSIRKE AND TANSSTAD 2005
44.	KING MACKEREL	SCOMBEROMORUS CAVALLA	MODERATELY TO FULLY EXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
45.	ARAUCANIAN HERRING	STRANGOMERA BENTINCKI	OVEREXPLOITED	SOUTHEAST PACIFIC	CSIRKE 2005
46.	WHITE MARLIN	TETRAPTERUS ALBIDUS	OVEREXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
47.	ATLANTIC BLUEFIN TUNA	THUNNUS THYNNUS	OVEREXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
48.	CHILEAN JACK MACKEREL	TRACHURUS MURPHYI	FULLY TO OVEREXPLOITED	SOUTHEAST PACIFIC	CSIRKE 2005
49.	NORTHERN ATLANTIC SWORDFISH	XIPHIAS GLADIUS	MODERATELY TO FULLY EXPLOITED	WESTERN CENTRAL ATLANTIC	COCHRANE 2005
SERRA SPANISH MACKEREL	SCOMBEROMORUS BRASILIENSIS	UNKNOWN	WESTERN CENTRAL ATLANTIC	COCHRANE 2005	

Primary Source: FAO 2005. The chapters on SE Pacific, SW Atlantic, West Central Atlantic, and East Central Pacific are cited in Column 5 above.

Notes: This follows the FAO classification of status between depleted, fully to overexploited, moderately to fully exploited, overexploited, recovering, and underexploited.

This table only includes those resources for which scientific data exist. Those resources for which the status is unknown are not included here.

§ Preliminary data.

* The Chilean stock is "fully to overexploited", and the Peruvian stock "recovering from overexploitation"

CHAPTER 8. FORESTRY

Rodrigo Martinez²²



8.1. INTRODUCTION: FOREST RESOURCES, DEVELOPMENT, AND SUSTAINABILITY

The Latin America and Caribbean region (LAC) is home to the world's largest rainforest the most biodiverse biome on earth. There are also many other kinds of tropical forests, temperate forests, savannas, and semi-arid biomes, each critical for biodiversity conservation. This ecologically rich set of forests has extraordinary potential to provide ongoing ecosystem services (ES) of economic significance, including water, food, wood, fiber, carbon sequestration, non-timber forest products (NTFP), and tourism destinations, as well as erosion control, flood mitigation, water purification, pollination, waste assimilation, and disease regulation.

Box 8.1. Sustainable Forest Management

“Sustainable forest management ... aims to maintain and enhance the economic, social and environmental value of all types of forests, for the benefit of present and future generations. It is characterized by seven elements: (i) extent of forest resources; (ii) forest biological diversity; (iii) forest health and vitality; (iv) productive functions of forest resources; (v) protective functions of forest resources; (vi) socio-economic functions of forests; and (vii) the legal, policy and institutional framework.”

Source: UN 2008

Despite the many links between forests and human welfare, current patterns of forest use are largely unsustainable. Extraction rates exceed the capacity of these forests to regenerate. Conversion of forest lands to other uses frequently involves lands that cannot sustain those uses and are soon abandoned, reverting to degraded forest. These approaches do not realize the long-term potential of forest-based ES to support income generation, development, and social equity, through the potential of the forests to sustain themselves.

The loss of forests is clearly visible and staggering. However, its far-reaching impacts have yet to be fully acknowledged. There is a direct correlation between loss of forests and reduction of critical ES. If current degradation trends continue, the decline of ES availability for the following decades will affect a higher proportion of low income rural communities (MA 2005). These communities, isolated from cities and markets, are directly dependent on biodiversity and other forestry resources for their wellbeing. Growing populations will raise the demand for forest products in LAC countries. Existing natural areas will continue to be threatened, further reducing options for those economic activities dependent on forests.

Traditionally, extraction of forest resources has occurred in unsustainable forms, primarily for rapid monetary gain. Due to concerns by environmental groups and buyers of forest products, forest management has been evolving to address ongoing depletion of natural forests and loss of ES. Alternatives to traditional forest management can balance conservation with local development, while

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still providing revenues to forestry firms and the region. Sustainable forestry (see Box 8.1) is dependent on management approaches that consider environmental sustainability and social responsibility, as well as continued economic returns. Examples include sustainable forest certification and adoption of improved harvesting practices such as reduced impact logging (RIL).

As natural resources are depleted, the value of biodiversity and ES increases, fostering innovative business models for NTFP, carbon markets, and payments for environmental services (PES). These business models combine natural resource conservation with economic and social development, engaging many stakeholders, from local communities to private and public entities.

This chapter will compare the costs and benefits of using forests under current Business-As-Usual (BAU) approaches, with those from a Sustainable Ecosystem Management (SEM) approach.²³ BAU is characterized by unsustainable forest exploitation, leading to natural

resource depletion and deterioration of local economies. This type of resource use is often followed by land-use change, for example to “slash and burn” agriculture and extensive cattle ranching. Negative impacts of forest resource use are externalized.

In contrast, Sustainable Ecosystem Management (SEM) refers to forestry practices that take into account all the effects of resource use and pursue positive overall results on all sides. This SEM approach includes sustainability of the resource use, respect for the rights of people living inside or close to forests, and fair distribution of benefits from the use of public resources.

BAU practices are not inherently negative but, rather, evolved in response to earlier conditions with a relative abundance of resources. These practices have met with success: the current size of the forestry sector and its importance to each LAC country economy has been achieved primarily by BAU practices. However, with that growth, BAU has tended to create the conditions for its own demise: growing scar-

Table 8.1. Intensity Levels of Forest Management in LAC

FOREST MANAGEMENT INTENSITY	TYPE OF FOREST	TYPE OF USE AND PRODUCTS	FOREST SPECIES DIVERSITY	TYPE OF USER	LEVEL OF MECHANIZATION	LEVEL OF INVESTMENT	NATURAL RESOURCE CONSERVATION	PROFITABILITY	INCLUSION OF SUSTAINABILITY CRITERIA	SOCIAL COSTS OF PRODUCTIVE PRACTICES
Low Impact	Native forest, Agroforestry	Subsistence use NTFP & fuel wood gathering	High diversity	Individual farmers Rural communities	Low, Artisanal	Low	High	Important to livelihoods & additional rural income	Low to medium Certification for some NTFP (certification expensive for smallholders)	Low
Medium Impact	Managed native forest Native or mixed species plantations	Low input selective logging High value native & exotic timber. NTFP production	Medium to high diversity	Forest concessions; Small to large landholders	Medium to high; RIL logging	Medium	High to medium	Medium to High	Medium to low Some FSC & PEFC certification	Low to medium
High Impact	Heavily intervened native forest Exotic tree monocultures	High input selective logging; High value native & exotic timber. Heavy NTFP extraction	Low diversity or monoculture	Small to large timber & reforestation firms	Medium to high; RIL logging	High	Low	High	Low under BAU High under SEM: FSC & PEFC certification	Medium to high
Very High Impact	Forest conversion	Clearcutting; Land use change	Low diversity	Smallholders to big firms	Variable; CL logging	Variable	Very low	Variable; short term high; long term low	None	High

²³ The term Sustainable Forest Management (SFM) is widely accepted in forestry; Sustainable Ecosystem Management (SEM) is used here for consistency with the other chapters.

city of key resources, large externalized impacts, and narrowly focused benefits, as well as a more prosperous society now more concerned with lasting, equitably distributed costs and benefits. SEM is a response to those new conditions, building on the BAU platform to improve sustainability, equity, and overall efficiency of forest resource use.

To frame the analysis of this chapter, three intensities of forest management ranging from low to high impact are characterized, using several variables to differentiate them (Table 8.1). The chapter will explore how, by adopting SEM practices, the forestry sector can continue to be a dynamic pole of rural economic growth, while playing a role in the development of sustainable livelihoods for forest communities and preserving the natural environment. For each level of forest management intensity in Table 8.1, the information will show which SEM practices produce better social and economic returns for forest users, and regional and national growth, if adopted successfully. These best practices should encourage sustainable long-term revenues of the public and private sector, and support the economic growth of LAC nations.

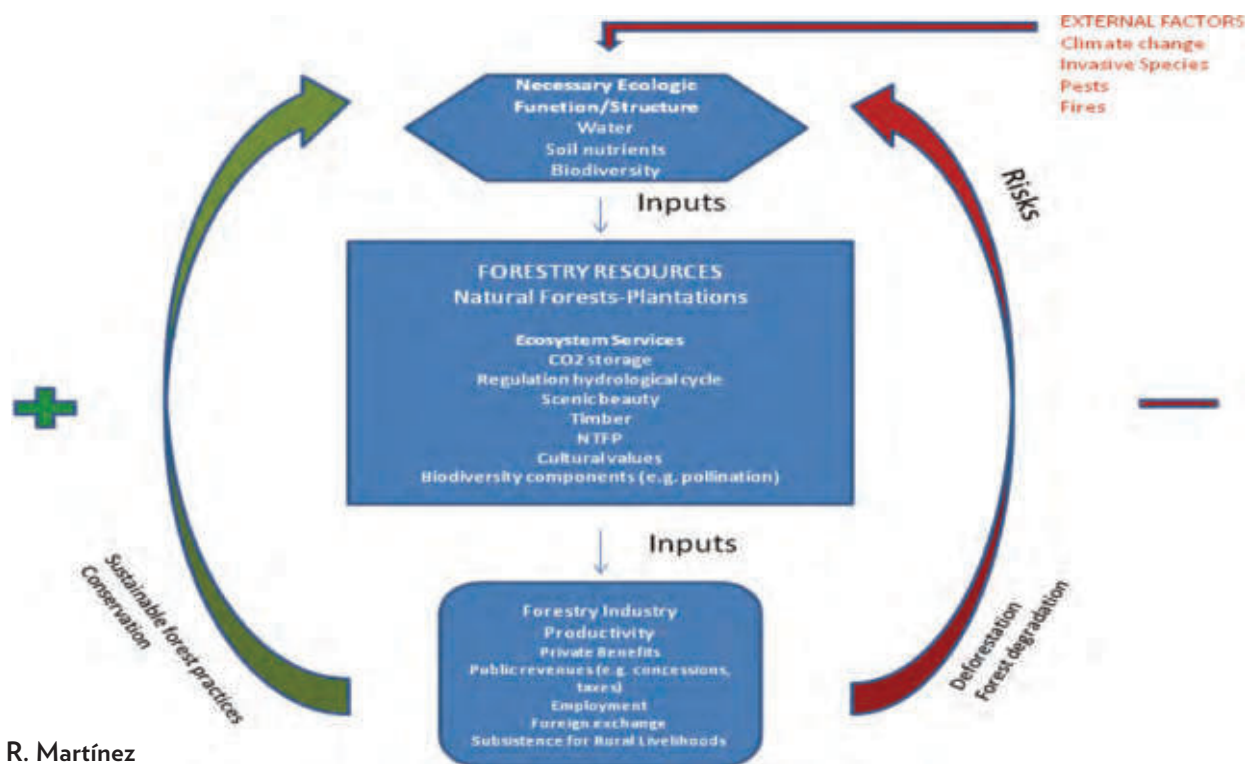
To make the comparison between BAU and SEM forestry approaches, the chapter will rely primarily on case studies to highlight the economic and social results of BAU, and to portray the benefits of moving toward SEM. These real world examples will do so by focusing attention on the indicators depicted in Figure 8.1, where information was available, and by highlighting the interrelations between natural forests, plantations, and ES, and the related benefits for society. A se-

ries of concrete policy recommendations will be highlighted to guide the appropriate engagement of governments and institutions in the transition from BAU to SEM.

KEY FINDINGS

- Forestry production in LAC depends heavily on biodiversity and ES; decisions to convert remaining forests — most of them on slopes and otherwise fragile environments — to other land uses or to mine this natural resource seldom consider long-run economic costs of deforestation and forest degradation.
- SEM practices can lead to reduced costs, avoid over-capitalization, and realize higher profitability for community enterprises and private firms, while also improving fiscal revenues.
- Successful market-based drivers of SEM currently being explored include PES, certification of sustainable production, and certification of carbon sequestration and avoided CO₂ emissions through REDD+ schemes. Programs to certify sustainable management are essential to formalize the sector, improve governance, gain access to training, opt for sustainable approaches to forest resources, and open previously inexistent markets for value-added products.
- SEM can serve as a framework to promote social and gender equity by emphasizing vulnerable communities, the rural poor,

Figure 8.1. Interrelation of Ecosystem Services and Forestry Resources



Source: R. Martínez

and supporting the role of women — for example, in adding processing value to NTFP.

- Data on key forest-based economic processes and their relation to ecosystem functioning needs improvement, if the sector is to harness sustained future benefits from forest resources and ES.
- Forest use, if not planned, implemented, monitored, and controlled adequately by SEM principles, may not be able to compete with alternative land uses such as agriculture.
- Climate change will pose an additional threat to current pressure on forests. Resilience to some adverse effects of climate change will come from adopting SEM practices.

8.2. FORESTRY IN LAC

EXISTING FOREST RESOURCES IN LAC

LAC contains the world's largest block of rainforests, as well as extensive temperate forests, totaling about 22% of the world's forest. Within the region, 90% of the forested area is located in South America, 9% in Central America and Mexico, and 0.4% in the Caribbean. The countries with the most forest cover are Brazil (475 million ha), Peru (68 million), Mexico (63 million), Colombia (60 million), Bolivia (59 million), and Venezuela (50 million): a total of 775 million ha or 84% of the total forest area in LAC (see Table 8.2). In the Amazon basin alone, 25% of about 675 million ha of natural forest are considered to be production forests (CATIE 2008).

South America also holds 86% of planted forests in LAC, notably in Brazil, Chile, and Argentina (Table 8.2). Central America has 10% and the Caribbean 3% of the region's plantations. The species most used are pines, eucalypts, and Paraná pine (*Araucaria angustifolia*). In 2000, the 13M ha of plantations were only 1.4% of LAC's total forest area but represented 9.4% of planted forests worldwide (FAO 2006a; Del Lungo et al. 2006b).

Of tropical forests in LAC, according to the International Tropical Timber Organization (2006), 6.5 million ha (7.5%) of forests have management plans, with 4.2 million ha (4.9%) under certification. In comparison, Sustainable Ecosystem Management plans cover 15% of natural forests in Asia, with 5% certified.

FOREST COVER IN LAC

Forest cover has been in continuous decline in most LAC countries. The annual net loss for 2000-2005 amounted to 4.5 million ha, which was 61% of annual global net loss. Between 1990 and 2005, the region lost 64 million ha, 7% of its forested area (Table 8.3; FAO 2009). All South American countries registered a net forest loss between 2000 and 2005 except Chile and Uruguay, which had positive trends because of large-scale industrial plantation programs. All Central America countries, with the exception of Costa Rica, experienced forest loss greater than 1 percent per year between 1990 and 2005 (FAO 2006a).

In contrast, the Caribbean sub-region experienced a net increase of forest cover, with a larger forested area documented both in 2000 and 2005 than during the previous measurement (Table 8.3), with the majority of increase occurring in Cuba (FAO 2006a). This trend is the result of natural restoration in areas previously used for agriculture. In some parts of LAC, there is also an expectation that more protected natural areas will result from nature-based tourism including more forested areas (FAO 2009).

KEY STAKEHOLDERS

In most LAC countries, rural communities dependent upon forest resources and small- to medium-scale forest enterprises comprise the largest group of direct actors within the forestry industry.

In 2005, about 78% of South American forests were owned by the public sector, 20% by the private sector, and 2% by other types of owners (FAO 2010). Of private forest concessions in Latin America and the Caribbean, 30% are foreign-owned (Scherr et al. 2004). In terms of management rights, approximately 77% are held by public entities, 3% by corporations, 16% by communities, and 4% by other actors (FAO 2010). Mexico is a special case in that 80% of forest lands are managed by more than 3,000 ejidos and communities (Hayward 2010).

Despite the fact that the state is generally the main owner of the forests and –on paper– regulates and controls their use, limited financial and human resources make it difficult to enforce these regulations. Often, the state shares its responsibilities with the private sector, either through concessions, recognition of territorial user rights, or shared management schemes without ceding its rights (as in protected areas).

On the other hand, decentralization of forest management at the municipal level, when implemented successfully, has played an important role in the growth and distribution of benefits from forest resources. Decentralization has also served to enable better enforcement of regulations, control of illegal exploitation, and social auditing of forestry activities and actors. Table 8.4 describes some of the decentralization processes that countries in LAC have implemented. These processes correspond to institutional measures that strengthen SEM.

Table 8.2 Forest cover in LAC in 2000

COUNTRY/SUBREGION	LAND AREA (THOUSAND HECTARES)	NATURAL FOREST AREA (THOUSAND HECTARES)	% NATURAL FOREST	PLANTATIONS (THOUSAND HECTARES)
Anguilla	8	0	0.0	-
Antigua y barbuda	44	0	0.0	-
Aruba	19	0	0.0	-
Bahamas	1,388	515	37.1	0
Barbados	43	2	4.7	-
Bermudas	5	0	0.0	-
British virgin islands	15	0	0.0	-
Caiman islands	26	0	0.0	-
Cuba	11,086	2,319	20.9	394
Dominica	75	46	61.3	n.s.
Dominican Republic	4,873	0	0.0	-
Granada	34	4	11.8	n.s.
Guadalupe	171	79	46.2	1
Haiti	2,775	81	2.9	24
Jamaica	1,099	325	29.6	14
Martinique	110	45	40.9	1
Montserrat	10	4	40.0	-
Netherlands antilles	80	0	0.0	-
Puerto rico	895	0	0.0	-
Saint kitts y nevis	36	0	0.0	-
Santa lucia	62	0	0.0	-
San vicente and the grenadines	39	10	25.6	n.s.
Trinidad y tobago	513	211	41.1	15
Turks y caicos	43	0	0.0	-
Virgin islands (us)	34	0	0.0	-
TOTAL CARIBBEAN	23,482	3,641	15.5	449
Belize	2,296	1,653	72.0	-
Costa rica	5,110	2,387	46.7	4
El salvador	2,104	292	13.9	6
Guatemala	10,889	3,816	35.0	122
Honduras	11,209	4,618	41.2	30
México	195,820	63,180	32.3	1,058
Nicaragua	13,000	5,138	39.5	51
Panamá	7,552	4,233	56.1	61
TOTAL CENTRAL AMERICA AND MÉXICO	247,980	85,317	34.4	1,332
Argentina	278,040	31,792	11.4	1,229
Bolivia	109,858	58,720	53.5	20
Brasil	851,488	475,314	55.5	5,384
Chile	75,663	13,460	17.8	2,661
Colombia	113,891	60,399	53.0	328
Ecuador	28,356	10,689	37.7	164
Malvinas	1,217	0	0.0	-
French Guiana	9,000	8,062	89.6	1
Guyana	21,497	15,103	70.3	-
Paraguay	40,675	18,432	45.3	43
Peru	128,522	67,988	52.9	754
South Georgia and Sandwich Is.	409	0	0.0	-
Suriname	16,327	14,769	90.5	7
Uruguay	17,622	740	4.2	766
Venezuela	91,205	50,0001	54.8	-
TOTAL SOUTH AMERICA	1,783,770	825,468	46.3	11,357
TOTAL LATIN AMERICA AND CARIBBEAN	2,055,232	914,426	44.5	13,138

Table 8.3 Forest area: extent and change

SUBREGION	AREA (1000 HA)			ANNUAL CHANGE (1000 HA)		ANNUAL CHANGE RATE (%)	
	1990	2000	2005	1990-2000	2000-2005	1990-2000	2000-2005
CARIBBEAN	5.350	5.706	5,074	36	54	0,65	0,92
CENTRAL AMERICA	27.369	23.837	22,411	-380	-285	-1,47	-1,23
SOUTH AMERICA	890.818	852.796	831,540	-3,802	-4,251	-0,44	-0,50
TOTAL LATIN AMERICA AND THE CARIBBEAN	923.807	882,339	859,925	-4,147	-4,483	-0,46	-0,51
WORLD	4,077.291	3,988,610	3,952,025	-8,868	-7,317	-0,22	-0,18

Source: FAO (2006a).

Note that areas for 2000 do not coincide with those in Table 8.2. In particular, Mexico is apparently not included here in Table 8.3, greatly lowering the total area for Central America (Table 8.2 lists Central America and Mexico together).

8.3. DEFINING BAU AND SEM FOR LAC FOREST

BUSINESS AS USUAL (BAU)

BAU economic and social gains in the forestry sector accumulated over centuries and helped found important trading centers and generate exportable surplus for much of LAC. The abundance of forest resources – until even a few decades ago – low population densities, and demand from growing economies made the BAU model effective for society. Areas being cleared for timber and pasture likely benefited the population more than would have leaving forest stands intact. This could still be true in some places; but, recent rates of deforestation, biodiversity loss, and global carbon emissions from deforestation (18% of the total of carbon emissions) made evident decades ago that BAU is unsustainable for most of LAC.

In general, BAU refers to maximizing short-term gains from the exploitation of forest resources without consideration of off-site or longer-term effects or of externalized costs. In LAC, BAU is characterized by:

- 1) Extensive, unregulated timber harvest, often with high-grading and environmental damage,
- 2) Little involvement of state agencies in forest management,
- 3) Large areas of forest being converted to grazing and agricultural land, often quickly depleted and abandoned,
- 4) Continuous uncontrolled settlement along rivers and roads, and

5) Marginalization of local populations and a lack of mechanisms to mitigate the impacts of land-use change and to adapt forest populations to this change.

Harvesting under BAU is typically done by conventional logging (CL), resulting in damage to residual stands, erosion and compaction of soils, and sedimentation of waterways. Land holders often contract with logging companies, seeking a low-cost route to short-term revenues and/or to land tenure via forest clearing. These logging operations tend to use older, inefficient machinery, lack planning and business skills, and have little control over impacts on the land or the concessions. CL practices are often highly destructive to forest ecosystems; heavy machinery can compact the soil and destroy saplings, while high-volume harvesting can foster erosion, reduce species diversity, and lessen regenerative capacity (CIFOR 1998). Forest products from rural and indigenous communities may be sold at prices below market, with the profits accruing mainly to large companies. BAU clear-cutting practices generate short-run income but are less financially attractive over the long run, with diminishing returns and higher net costs (CATIE 2008).

On the NTFP side, overharvesting is chronic under BAU, with products extracted at higher rates than of natural replacement. Rattan was one of the first documented examples of overharvesting (de Beer et al. 1989). Palm heart overharvesting has been shown to underlie the decline in palm heart production from forest-growing species observed over the last thirty years (CATIE 2008).

Forestry actors and institutional settings of BAU: Under BAU, government control over the forests in most places is weak, using a short-term perspective. In general, BAU situations are associated with lax regulation and frail institutional frameworks associated with

Table 8.4. Decentralization of Forest Management At The Municipal Level

COUNTRY	PERIOD	PROCESS	BENEFITS	LIMITATIONS
BOLIVIA	Mid-1990s ¹	Forest management decentralization that allows municipalities to control up to 20% of national forests within their jurisdiction.	Bolivia is one of the LAC countries with greatest decentralization at the municipal level. Municipal governments are able to award forest concessions or rights for forest exploitation for small-scale loggers and other traditional forest users. 25% of forest license fees goes to municipal governments.	Central government still remains powerful in terms of policy-making for the forestry sector.
HONDURAS	1990s	Decentralization of forest ownership & management to municipal level for 28% of forests.	Important economic benefits for municipalities when they became owners of significant extensions of forests.	The need of improvement in forest management and control skills at the local level.
GUATEMALA	n.d.	Decentralization of forest activities via technical assistance and technology transfer to municipalities, with funding mechanisms (PINFOR Forest Incentive Program).	The transfer of 50% of the tax revenue on concessions and timber licenses from the central to municipal governments, which control and oversee forest resources, support reforestation programs, implement forest plans, and collect local taxes.	Municipalities still lack of power to implement own forest policies
NICARAGUA	Mid-1990s ²	Municipal strengthening to develop, conserve and control the environment and natural resources at the local level.	Municipal roles: vetting logging contracts, receipt of 25% of fiscal revenues from forest contracts, establishment and management of natural parks; plus promotion of agroforestry and reforestation projects, granting domestic felling permits, developing land-use plans, collecting taxes and fines for legal and illegal logging, and management of forestry funds.	Low municipal budgets and insufficient transfers of resources from the central government, as well as legislation and practices that reinforce a centralized forest management.
BRAZIL	n.d.	While decentralization of environmental & natural resource competencies is not yet widespread in Brazil, local governments have big indirect impacts on forest resources by developing municipal infrastructure and managing credit funds.	Implementation of forest control programs, modernization of the timber industry, forestry and agroforestry promotion, as well as of forest certification, and support for NTFP extraction; support from nongovernmental organizations and projects supported by the federal government.	Forest management lags, still highly centralized; the entity charged with forests has little clout, is unable to oversee forest management plans. Municipalities depend on state and federal transfers, reducing motivation to find forest-related alternative revenue sources.
COSTA RICA	Mid-1990s ³	One of LAC's more centralized models with regard to forest resources, relatively successful centralized tradition; population and economy concentrated around capital.	Despite the existence of several fund collection mechanisms for municipalities, they have not been able to exercise forest competencies due to political and legal obstacles.	Municipalities play only a minor role and have no direct effect on forest management. Some competencies were transferred to local governments without any technical and administrative training.

the agricultural frontier. Low taxes on agricultural income and fiscal incentives that favor pasture over forest tend to overvalue agriculture and rangeland, and to boost the profitability of forest conversion. Lack of understanding of the ES provided by forests further fosters forest conversion. Illegal extraction is often commonplace, sometimes depleting the more valuable species (CATIE 2008).

SUSTAINABLE ECOSYSTEM MANAGEMENT (SEM)

SEM is sustainable management of forest ecosystems. The SEM approach consists of practices to obtain sustainable benefits from forest resources, while conserving the biodiversity and ecological balance of the forest and maintaining provision of ecosystems services.

Typically, SEM encourages creation of long-term jobs, gender and economic equity, and income-generating activities for local communities. (See Box 8.5 for an illustrative case study of SEM practices in forestry.)

Both in natural forests and plantations, the SEM approach is versatile and can be adapted to different forest types and socio-economic circumstances, with silvopastoral, agroforestry, and sustainable cultivation systems among the potential management options. SEM uses tools such as reduced impact logging (RIL) to help manage the forest for the long term. RIL systems use harvesting techniques that reduce damage to residual trees, limit soil disturbance and erosion, protect water quality, mitigate fire risk, maintain and encourage

Box 8.4: Forestry Management Sustainable Practices

- Mixed-species plantings are preferable to monocultures, due in part to their increased structural complexity;
- Different-aged stands in ecosystems that are not fire-dominated;
- Extending rotation length benefits biodiversity, particularly favoring diversity of soil biota and species associated with dead wood or leaf litter (Ferris et al. 2000; Magura et al. 2000),
- Maintaining snags, logs and other woody debris on site can also enhance habitat values for a range of species, from fungi to cavity-nesting birds; and
- Management practices that improve soils rather than degrade them. Practices such as spot cultivation, use of amendments, retention of harvest residues, and decreased disturbance during site preparation and harvest help maintain soil fertility and the diversity of soil organisms, essential for nutrient conservation and cycling.

Source: Johnston et al. (2002).

natural regeneration, and protect biological diversity. RIL techniques and guidelines are not fixed prescriptions, but is an approach that adapts harvesting options to existing biophysical and economic conditions based on site-specific assessment and planning.

The FAO model code of forest harvesting (Dykstra et al. 1996) is the basis for RIL system design. This code, typically, includes many or all of the following activities, which imply substantial up-front costs, including preparation and coordination of personnel. Such costs are recovered from more efficient use of equipment and of harvesting options, as well as reduced loss of felled stems and better forest re-growth (see also Box 8.4.).

- pre-harvest inventory and mapping of trees,
- pre-harvest planning of roads and skidtrails,
- pre-harvest vine cutting,
- directional felling,
- cutting stumps low to the ground,
- efficient use of felled trunks,
- constructing roads and skid trails of optimum width,
- winching of logs to planned skid trails,
- constructing landings of optimal size, and
- minimizing ground disturbance and slash management.

Certification: In many cases, the social and ecological benefits of SEM are verified by certification. Besides ensuring sustainable extraction, forest certification assures civil society control of the process, and a focus on long-term gains that often favors value-added products. Certification also addresses labor conditions to ensure that these conditions meet international standards, thereby minimizing accidents and work-related illness. Certification schemes permit entry into market niches that exclude products from unsustainable sources. While some negative ecological effects may occur under SEM, this approach is subject to strict control, specific regulation, and institutional frameworks, so that long-term preservation of ES is enhanced.

Forestry actors and institutional settings of SEM: Under a SEM scenario, large companies manage private forests or concessions. Small- and medium-sized companies and communities have greater access to markets, financial services, and processing facilities, all fostering regional income, employment, and capital investment. Timber harvest in community-owned forests is done by communities and integrated within their land-use systems, complementing their income from low impact agriculture and other economic activities (CATIE 2008).

Under SEM, many successful NTFP can be cultivated in areas adjacent to communities, where they compete and rotate with other agricultural products adapted to local conditions. In these same areas, forest plantations will supply a growing part of the timber, paper, and pulp industry. Forest management will be adaptive, oriented at maintaining the resilience of the ecosystem in the face of climate change, ensuring regeneration of the harvested trees and avoiding situations that affect forest-based ES (CATIE 2008).

Transparent market information for SEM: Market information is openly accessible for all actors under SEM. Forest product markets have chain-of-custody mechanisms to track the origin of the products sold. Such transparency provisions are supported by certification standards, government regulations, and monitoring and enforcement measures. Systems also reward forest owners for the production and maintenance of ES, which generate funds from both market and non-market sources (see Section 8.7).

8.4 ROLE OF FORESTRY IN LAC NATIONAL ECONOMIES

Forestry plays a significant role in many countries of LAC. Forest-based products constitute an important part of primary economies and rural communities, and are essential to survival in many remote populations. Well-managed forests can generate long-term income and employment, especially in rural areas.

Box 8.5. Case Study Futuro Forestal Forestry Company

Futuro Forestal is a private German-Panamanian Reforestation and Investment Service Company that in the last 15 years has developed an innovative model for ecologically and socially sustainable reforestation in the tropics. The Company is currently managing 16 M trees in Nicaragua and Panama (eastern Darien and Cebaco Island). Futuro Forestal manages forest projects for large investors, taking into account high returns on forest investment and optimized growth performance, as well as nature preservation, enhanced biodiversity, and social responsibility.

The projects use a system of mixed plantations, planting teak (*Tectona grandis*) as the only introduced species, and six native species with high commercial value: amarillo (*Terminalia amazonia*), mahogany (*Swietenia macrophylla*), spine eedar (*Bombacopsis quinatum*), almond (*Dipterix panamensis*), zapatero (*Hyeronima alchorneoides*), and rosewood (*Dalbergia retusas*). In addition, about 65 native species of lesser value are planted to increase system stability and biodiversity.

With Futuro Forestal, investors buy 1 ha parcels for \$24,990 and receive direct title land ownership in Panama, Panamanian tax-free profits from the sale of the timber, and an annual IRR of 11% on a 25-year term from timber, seed, and carbon credit sales.²

Depending on species, after 20-30 years of growth and silvicultural management, Futuro Forestal expects to have about

400 crop trees/ha to harvest, with heights of 25-35 m. Most trees will reach heights of 20 m within their first 4-8 years and the first income will be generated with the different thinnings that occur at years 10, 15, 18, 22, and 25.

The lands chosen by the company for implementing reforestation projects are characterized by being previously deforested and used for agriculture or cattle. Futuro Forestal will transform those areas into forests again with native species in ratios and spacings that are adjusted to the conditions of each site. The forests created will come closer to a primary forest than do other plantations. 25 % of the land is reserved for natural regeneration.

These mixed species plantations emulating high biodiversity create a stable ecologic system in the forest that will result in low vulnerability to plagues. That stability increases growth and health of the forest, leading to **better yields and higher quality timber**. Areas are certified by FSC (Forest Stewardship Council) through the SmartWood Program.

Futuro Forestal pays about average salaries with social security benefits and offers proactive training courses for its employees, such as literacy programs and computer courses. The project is now employing 50 full-time and 80 seasonal workers. The project has also helped farmers in the area learn about the benefits of reforestation.³

¹ Futuro Forestal. Viewed online 1 Aug 2010. Published 19 May 2009 http://wiki.hardwood-investments.net/Futuro_Forestal.

² Futuro Forestal. *Balancing Nature and Business* http://www.escapeartist.com/Futuro_Forestal/Futuro_Forestal.html, Viewed 1 Aug 2010.

³ Anderson, B. *Timber Investments in Panama*. Online <http://www.nuwireinvestor.com/articles/timber-investments-in-panama-51311.aspx> Published on: Monday, October 29, 2007. Viewed August 1, 2010

Logging is currently the main source of income in the forestry sector, but NTFP are also important sources of revenues for rural companies and for community forestry initiatives (Section 2.5).

GROSS DOMESTIC PRODUCT (GDP)

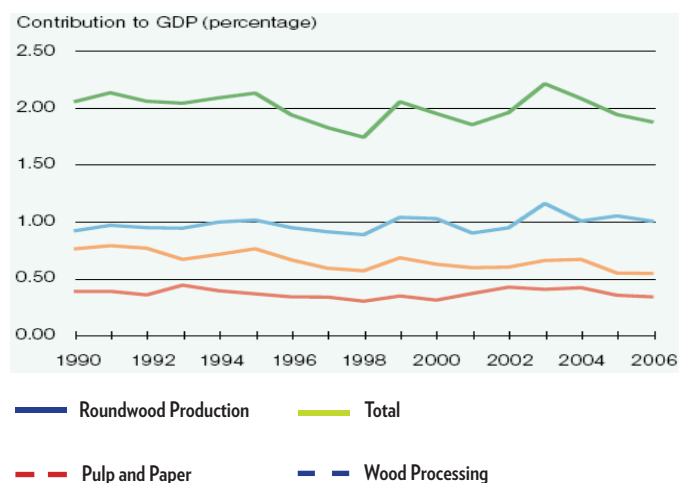
On average, logging activities in LAC contribute 2% to GDP (Figure 8.2). From 1990 to 2006, forestry's GDP share grew from \$30 billion to \$40 billion (2006 dollars), mostly from roundwood production (Figure 8.3). This amount refers only to commercial value and does not cover the potentially greater value of forest products and ES used directly or indirectly by rural populations (FAO 2008). The emerging focus on ES is significant enough to help motivate a switch from BAU to SEM in LAC, to make logging sustainable. The

switch is still in progress: currently, most roundwood production is from plantations (Section 2.4).

EMPLOYMENT

The forestry sector plays an important social role in LAC by creation of jobs. According to FAO (2008), employment in roundwood, pulp and paper, and wood processing industries reached 1.5 million in 2006, 0.75% of the regional total (Figure 8.4). Counting all activities, formal and informal, in 2001 the forestry sector provided more than 8 million jobs, of which 2.7 million (32%) were formal (FAO 2006b). These figures provide an indication of the forestry sector's contribution to poverty alleviation, since forestry activities occur in rural areas, which are generally underprivileged in relation to other

Figure 8.2 Contribution of Forest Timber Products to GDP in LAC



areas (FAO 2006b). Since the majority of employment in forestry is outside the formal sector, forest work is probably more significant for rural livelihoods and national economies than the reported figures suggest (FAO 2010).

EMPLOYMENT

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CONTRIBUTION TO FOREIGN EXCHANGE EARNINGS AND PRODUCTION

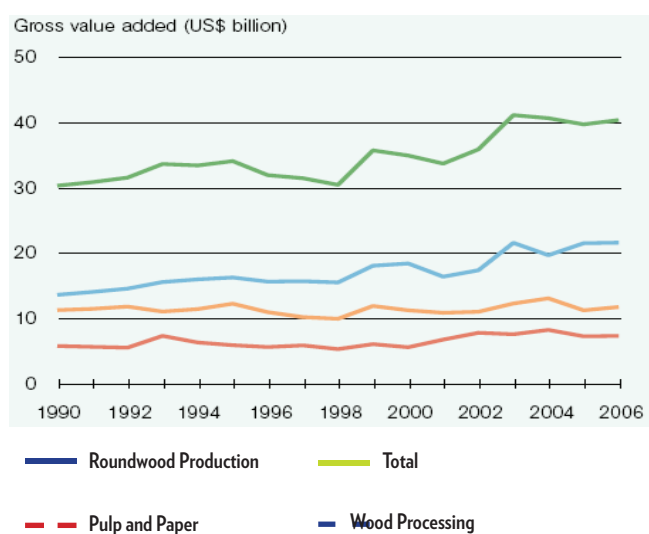
Exports of primary wood, secondary wood, and primary paper products in LAC increased from 1998 to 2005, reaching \$7.5 billion dollars per year, with a decline of about 30% in 2006 (see Figure 8.5).

CURRENT STATUS OF WOOD PRODUCTION IN LAC

The total volume of roundwood production from LAC reached 134 million m³. This represents about one third of Asia-Pacific, Africa, and LAC combined, with 63% of this amount coming from plantations that have had an important effect in reducing extraction from natural forests in several countries of LAC (FAO 2009).

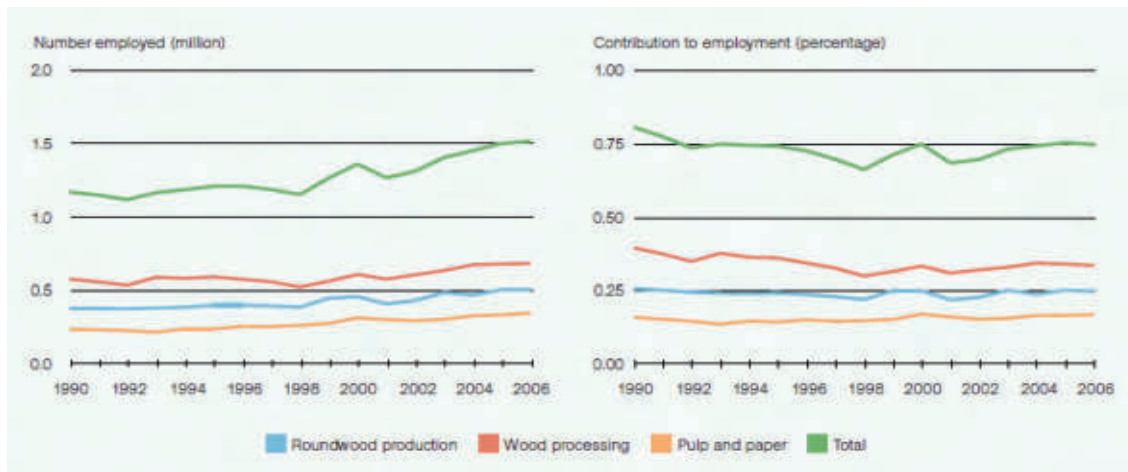
In natural forests, private long-term forest concessions manage the majority of the production. Bolivia, Guyana, and Surinam have the largest concessions, up to 200,000 ha. Guatemala, Peru, and Venezuela, in general, have medium-sized concessions; smaller scale concessions are found in Colombia, Ecuador, Honduras, and Trinidad and Tobago (ITTO 2006). In Brazil, forest products traditionally come from private land, but forest concessions have also been opened to logging in the Amazon as a strategy to avoid illegal occupation and to reduce logging pressure in conservation areas.

Figure 8.3 Forestry Production in LAC 1990-2006



Source: FAO (2008).

Figure 8.4 Employment Generated by Formal Sector Forest Industries in LAC, 1990-2006

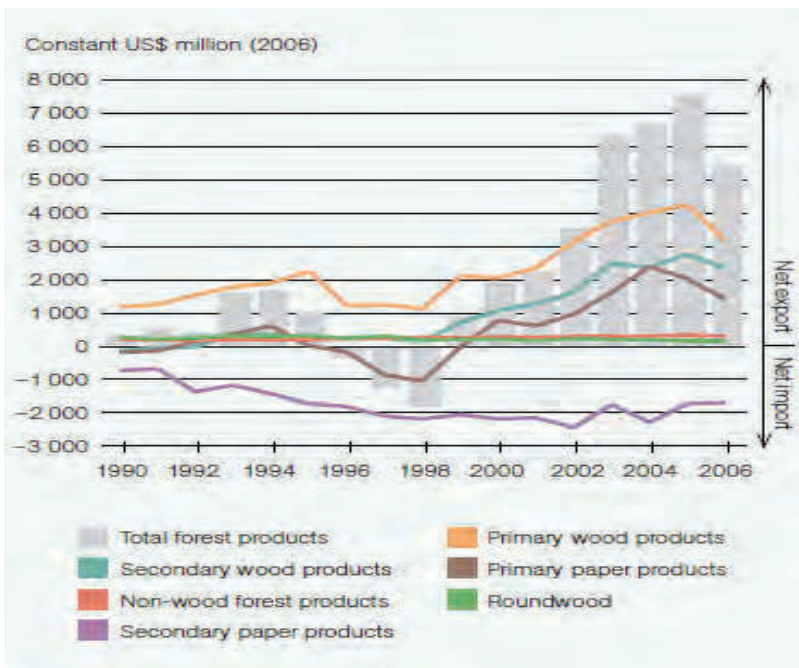


Source: FAO (2008).

NON-TIMBER FOREST PRODUCTS (NTFP)

Forests offer a wide range of NTFP, important both to industry and to rural residents. They include diverse fruits, nuts, seeds, oils, spices, resins, gums, fibers for construction, furniture, clothes, or utensils, and both plant and animal products for medicinal, cosmetic, or cultural purposes (UNEP-WCMC 2010).

Figure 8.5 Net Imports and Exports in the LAC Forestry Sector, 1990-2006



Sources: FAO (2008) and UN (2008e).

Food security, medicinal plants, and natural fibers: A large share of the world's poorest people depends on NTFP for survival and income. At least 40,000 species of plants and animals are used on a daily basis (CIFOR n.d.). NTFP can be extracted or produced directly from natural or planted forests. Examples of foods include Maya nuts (see Box 8.6), Brazil nuts, cacao, palm heart, a variety of edible roots, and many kinds of fruits. Once an NTFP attains consistent demand and market importance, it may no longer be produced in natural forests. For example, Brazil nuts and palm hearts are now being produced in plantations.

Women from low income households often rely on NTFP for home use and income. Improved management of NTFP has helped villagers generate more income from forest materials, while protecting the forests. About 80% of the population in the developing world use NTFP for health, nutritional, and household needs. At least 150 NTFP are traded internationally (Etherington 2008). Demand for medicinal plants is growing at such rate that the natural stocks in the wild are being destroyed. Hundreds of species are overharvested and face extinction if they are not protected or cultivated (Lambert et al. 1997).

Local depletion of tripeperro, used to make crafts and bags in Quindio, Colombia, was studied with a group of 80 craftsmen and 25 gatherers who spent from one to four hours to reach a forest where the raw material is still available. The average effort was 8.5 hours per trip, eight times longer than 15 years ago due to depletion of the resource closer to town (Ramos 1997). The study reported then that, with current extraction systems, there would be a scarcity of tripeperro in the nearby and intermediate woods within five years. To meet the demand craftsmen would have to increase the average extraction effort by two hours, costing the group of artisans \$8,500, or \$82 apiece.

Box 8.6. Case Study: Maya Nut Program

Mainstreaming traditional rainforest food drives conservation, stimulates economies and improves health in rural Central American and Mexican communities²⁴.

Background

Maya nut (*Brosimum alicastrum*) is a delicious, nutritious fruit of an abundant neotropical rainforest tree that provided a staple food for pre-Columbian peoples. The nut is an excellent source of high quality protein, calcium, iron, folic acid, fiber, and B vitamins. In recent times, Maya nut has been critical to rural food security; thousands of villages in Mesoamerica have survived drought and famine by eating the nut when no other food was available. Unfortunately, knowledge about Maya nut has fallen to near zero as globalization, export crops, and deforestation negatively influence indigenous culture and the forests that sustain these people. Loss of this indigenous knowledge led local people to cut down Maya nut trees for firewood and construction, and to burn Maya Nut forests to plant crops. The tree is in danger of extinction in much of its range, which threatens the food security of both human and animal populations.²⁵

Maya nut is an ideal staple and famine food due to its abundance, ease of harvest and processing, and good storage, nutritional, and culinary qualities. Each tree produces 50 to 300 kg of food yearly, which can be easily and quickly harvested from the ground during the two-month fruiting season. The nut tolerates drought and rocky shallow soils, making it apt for reforestation in degraded sites and in areas predicted to experience climate change-induced drought. Once established, plantations require little care and no inputs. A ten-year old plantation can give 23 tons of food/ha/year. When dried, the nut can be stored for five years, making it an excellent option for food-insecure families. Maya nut forests provide four-six times more calories, ten times more protein, and 100 times more micronutrients per hectare than corn. The nut provides a complete protein, similar to that of meat, making it a good food for low-income rural families.

The Healthy Kids, Healthy Forests campaign promotes local production and consumption of Maya nut to help solve malnutrition and economic crises in Mesoamerica and the Caribbean, where nearly 50% of rural children under five years old are chronically malnourished and under 10% of rural women work outside the home. Healthy Kids, Healthy Forests integrates rural economies, rainforest conservation, and health by focusing on women as caretakers of the family and the environment. Since 2002, 14,000 women from 800 villages have been trained on Maya nut for food and income generation; 6,000 children from 45 villages have been consuming the nut as part of a novel school lunch program.

BAU vs SEM

The current agro-economic paradigm in rural Central America, the Caribbean, and parts of Mexico does not seek to provide high-quality, locally produced food for people. The BAU model values input-intensive crops for export such as bananas, sugar, and coffee. This BAU model benefits established, elite landowners and market intermediaries, but exacerbates rural poverty, malnutrition, and socio-economic disenfranchisement by paying low wages, excluding producers from decision-making and free market opportunities, and usurping prime land for non-food crops.

One example is sugar production in Guatemala, where 200,000 ha of Maya nut forests on the south coast have been cleared to plant cane. Most sugar produced in Guatemala is exported (Suarez 1996), yet, workers earn only \$50/week. In comparison, if sugar fields in Guatemala were restored to Maya nut forests, within eight years they would yield 295,000 t/year of high-quality food, with a local value of \$535 million (at \$1,76/kg for dry Maya nut seed).

In the same vein, the BAU situation of school lunches in Guatemala also threatens food security, rural economies, and health. A typical school lunch in a rural Guatemalan school costs \$0.11/day/child and may include, boxed juice or milk, soup, rice and beans. Most of these items are purchased from large national or multinational corporations that import them. Conventional school lunch programs do little to stimulate the local economy.

The SEM approach of Healthy Kids, Healthy Forests seeks to create social and economic value for Maya nut by educating policy makers, private firms, communities, and families about the nutritional, economic, and environmental advantages of Maya nut compared to conventional crops. The Maya nut school lunch costs a bit more than the conventional model at \$0.15/day/child (Vohman 2010), but has the advantage of being produced locally by rural women, ensuring that every penny spent is also an investment in community enterprise.

COSTS OF TRANSITION FROM BAU TO SEM

Maya nut trees require several years to become productive. A cost-benefit analysis of Maya nut reforestation in Central America (Equilibrium Fund 2010) showed that the cost to establish the first hectare of trees is \$3,277 and \$1,696 for each additional hectare. If this forest is managed by a family or community to produce Maya nut flour, the forest will pay off the initial investment in reforestation and processing equipment purchase, yielding a net income of \$5,804 in the seventh year. By year 10, if managed for flour production, the forest will generate \$25,417/ha/yr.

²⁴ Prepared by Erika Vohman (2010), Director of The Equilibrium Fund.

²⁵ Many Mesoamerican wildlife species use Maya nut for food.

NTFP Markets

In the Amazon basin alone, formal trade in NTFP is valued at US\$200 million per year; this is less than 1% of the total forestry sector's value (CATIE 2008). The NTFP share of exports from the region is likewise very low compared to primary and secondary wood, and paper products (Figure 8.5). However, the total NTFP contribution to the forestry sector is unclear since NTFP processing industries are treated as manufacturing sector activities, rather than in the forestry sector. Markets have been largely informal, with little control by national and local authorities. (See Box 8.7 on financing biotrade.) Data on NTFP production and trade is scarce and, at times, imprecise, except for the few large-scale products (CATIE 2008).

In 2005, sale of NTFP in Peru generated over \$14 million, including products such as algarrobo (6.5 million kg/yr), cat's claws (0.5 million kg/yr), tara (3.9 million kg/yr), sangregado (1.1 million units/yr), palm-heart (0.2 million kg/yr), and a large number of medicinal and aromatic plants (CATIE 2008). One of the emerging products is camu-camu, promoted for its high vitamin C content; camu-camu is now grown in plantations, the latest example of domestication of highly successful NTFP, in addition to rattan, palm heart, and rubber. (See Box 8.6 on biotrade; See Box 8.7 on medicinal plants and producer associations.)

In Brazil, Bolivia, and Peru the brazil nut value chain provides direct employment to 15,000 people (FAO 2009). In Bolivia, brazil nuts constitute 45% of the country's forest-related exports, contributing \$70 million/year (CIFOR 2008a). The main Amazon NTFP in volume traded, value, and involvement of local actors are brazil nut in Bolivia, and palm heart in Brazil and Peru (ITTO 2006). In Costa Rica and Cuba, large amounts of honey are made in mangrove forests (Hernández et al. 2000).

NTFP Role in Poverty and Rural Livelihoods

Internationally traded NTFP are important to some sectors of LAC society. However, these products do not have the potential to easily transform local economies or social and cultural institutions and practices in positive ways. Commercially traded NTFP can generate real benefits for local groups, and, as discussed, may lead indirectly to species and forest conservation, but the greatest value for local groups is often found in subsistence use and local trade of NTFP (Laird, Wynberg, and McLain 2009).

In two villages (116 households) south of Iquitos in the Peruvian Amazon, Gram et al. (2001) studied the average value of products extracted per household from natural floodplain forest over a year (Table 8.5). Goods consumed by the households were distinguished from those sold.

These values were compared to the income generated from agricultural activities such as domestic animals and products from cultivated land after slash and burn practices (see Table 8.6). Domestic use was again separated from commercial sale.

Box 8.7. Providing Local Access to Finance: The BioTrade Fund in Colombia

According to the Humboldt Institute, in Colombia, biotrade products generate approximately \$25 million/year. Medicinal plants generate more than \$10 million/year in Colombia and natural ingredients used by the pharmaceutical industry represent \$8 million to \$10 million/year, having experienced a 50% growth rate in the last three years. Demand for biotrade products is expected to continue growing in the near future; this presents an opportunity to generate economic growth in Colombian rural communities.

Biodiversity-based companies need to access financial resources. This is a challenge for biotrade initiatives. The "Fondo Biocomercio" was created in December 2005 by the Colombian BioTrade Program (managed by the Alexander von Humboldt Institute). The program was launched as a non-profit that "aims to contribute to implementing the CBD objectives by providing financial services to enhance development of biotrade in Colombia." The BT Fund provides financial services to companies committed to complying with BioTrade Principles. Products and services financed include NTFP (medicinals, cosmetics, and foods), ecotourism, agricultural systems (e.g., farm products, agro-ecological practices, wildlife breeding), and timber products (wild timber species). Financial support has been received from the GEF via the World Bank and from the Netherlands Embassy. Since 2007, BioTrade Fund beneficiaries have improved by 40% and 50% on their environmental and social performance, respectively. From 2007 to 2009, 59 companies benefited from the BioTrade Fund. The total turnover by beneficiaries in 2008 was \$57.6 million. A total of 19,252 ha with over 300 species are currently under BioTrade practices; 707 jobs have been generated for communities and minorities; and 3,206 families benefit.

Source: Jaramillo 2010.

Box 8.8: “Jambi Kiwa” Medicinal Plant Producers’ Association, Ecuador

In Ecuador’s Andean Chimborazo province, one of the poorest in the country, 20 women started a pilot project in 1998 to improve their quality of life, foster gender equality, guarantee sustainable use of the surrounding natural resources, and capture the market potential of medicinal plants. The project was created during the crisis that led to dollarization of the economy. Despite difficulties related to the instability of the local currency, prices and costs, the initiative evolved into a community business (a SME) named Jambi Kiwa in 2001. A cooperative to grow, process, and market medicinal and aromatic plants, Jambi Kiwa involves more than 600 families (80% women with high levels of illiteracy; 75% indigenous Puruhá). Its success was fostered by mobilization of a wide range of community assets that were, in turn, used to lever considerable outside resources. With the support of the Sustainable BioTrade Programme in Ecuador, a three year project (2004-2008) was implemented in partnership with the Organization of American States (OAS).

The project promoted the economic development of minority groups by strengthening the institutional, business, and productive

capacities of Jambi Kiwa, and by consolidating its participation in national and international markets. Jambi Kiwa has accessed niche markets by differentiating its products through eco-certification schemes, quality certification, and biotrade practices. Recognized as a supplier of high-quality medicinal and aromatic plants to markets in Ecuador, Latin and North America, and Europe, Jambi-Kiwa has created a sustainable economic development model for localities that allows them to compete in national and international markets through the differentiation of their products. This differentiation was the result of a well-tailored strategy that aims to improve quality and product range, enhances processing capacities, and is supported by a solid communications and marketing plan.

The model led to the elimination of intermediaries, which allowed Jambi Kiwa to raise the price paid to producers for fresh plants from 8 cents/kg in 2001 to 20 cents/kg in 2003; the development of skills for identifying, collecting, growing, and harvesting medicinal and aromatic plants; and the certification of 420 producers in 38 communities.

Sources: Jaramillo (2010) and Coady International Institute (2004).

Total value of extracted products in the two villages was \$164,142 per year on 13,108 hectares. The average value of products extracted per hectare was \$13, and on average 113 hectares per household in the two communities was available. Viewed as an integrated system, NTFP extraction and agriculture together gave a value of \$21 /ha/year (Gram et al. 2001).

Torras (1999) and Saraiva et al. (2007) reviewed the literature on the value of selected NTFP/ha/year (Table 8.7). These findings reflect the generally modest but stable income levels that a farmer with several hectares can generate. A more complex but well-analyzed example is the case of xate palm frond harvesting in Guatemala (Box 8.9).

Table 8.5. Average value of NTFP / Household in Two Villages in Peru

TYPE OF PRODUCT	USED LOCALLY ¹	SOLD	TOTAL
Game	70	20	90
Animal by-products ²	6	4	10
Fish for food	678	222	900
Aquarium fish	1	122	123
Fruit	17	120	137
Timber and leaves ³	143	16	159
Crafts ⁴	32	19	51
Medicinal parts ⁵	23	7	30
Other plant products ⁶	4	9	13
Firewood	145	0	145
TOTAL	1.119	39	1.658

¹ Including local exchange of products.

² Eggs, smaller animals, et.

³ Materials for construction, e.g. timber for canoes and palm leaves for roofs.

⁴ For example, baskets, bows and ceramics.

⁵ Including plants not used in connection with illness but which are supposed to be beneficial for health

⁶ For example, honey and palm heart.

Table 8.6. Income Generated from Natural Forest vs. Agriculture in Two Peruvian Amazon Villages

ORIGIN OF PRODUCT/INCOME	USED LOCALLY	SOLD	TOTAL
Natural forest	1,119	539	1,658
Agriculture ¹	616	553	1,169
Other income ²	–	–	68
TOTAL	1,735	1,092	2,895

¹ Slash-and-burn farming including products from fallow and from domestic animals. Costs are deducted.

² Mainly wages and gifts, e.g. clothes from relatives in towns and food aid from religious organizations. the gifts counted here do not include traditional systems of exchange of local products.

NTFP AND BIODIVERSITY FOR PHARMACEUTICAL, COSMETIC, AND PERSONAL CARE INDUSTRIES

NTFP are also valued in the pharmaceutical, cosmetic, and personal care industry, where stakeholders include individual gatherers and traders, rural communities, small and medium producers and processors of raw material, and medium and large corporate buyers. Globally, these sectors are very large, producing \$735 billion annually (SCBD 2008 in TEEB 2009). The proportion following SEM practices is unknown.

Despite the importance of NTFP and biodiversity resources for those markets, the lack of clear legal frameworks to access the genetic resources through bio-prospecting agreements has been a disincentive for companies to invest in screening natural compounds found in forests and other ecosystems. The bio-prospecting market is still evolving, and has not yet generated significant direct investment or payments to local people. A recent global survey found 72 cases of biodiversity markets in 33 countries worldwide, of which 63 were in 28 tropical countries; 70% of the markets were international (Scherr 2004).

Both Costa Rica and Brazil have benefited from bio-prospecting agreements. Costa Rica has entered into agreements with over 30 pharmaceutical and agricultural research companies (Tamayo et al. 2004). The most well-known agreement involved Merck in 1991; under this bio-prospecting agreement, a variety of biodiversity resources were screened for new pharmaceutical compounds. The agreement stated that

50% of the benefits from the drug discovery and development phases would be divided with the National Biodiversity Institute (INBio) and the Ministry of Environment and Energy (MINAE). Shared profits, joint property rights, and development and training of Costa Rican scientists were also covered (Tamayo et al. 2004). No product coming from this agreement has reached the market, but 27 patents have been registered by Merck (Medaglia 2007). The cost of INBio bio-prospecting activities has been about \$0.5 million per year (Eberlee 2000).

In 2000, the Swiss multinational Novartis (1996 merger of Merck and Sandoz) entered an agreement with the Brazilian Association for the Sustainable Use of the Biodiversity of Amazonia (Bioamazonia). Novartis agreed to pay \$4 million for the ability to gather 10,000 samples/year for three years, and to pay more to Bioamazonia upon clinical testing, patent registration, and launch of any successful drug. They also agreed to give Bioamazonia 1% of royalties during the 10 years that Novartis retains exclusive rights (Peña-Neira et al. 2002). One weaknesses of this agreement is the lack of a requirement to use funds for biodiversity preservation, and for transfer of technology through engagement of Brazilian scientists.

The most important aspect of these agreements is the potential for building scientific, technical, and institutional capacity. Costa Rica benefited by developing its own research capacity to investigate diseases such as malaria and others that attack agriculture, and by better knowledge of the taxonomy, distribution, and natural history of Costa Rican species. However, in Brazil this benefit was less clear and the results are more in terms of the payments done to Bioamazonia (McClelland 2004).

Table 8.7. Value of NTFP Production in Different LAC Forests

AUTHOR	REGION	TYPE OF NTFP	VALUES
PETERS ET AL. 1989	Mishana region of the Peruvian Amazon	Food: data given on trees/ha, annual fruit production, and net price for each species	US\$ 400 / ha / year
		Raw Materials: Latex	US\$ 22 / ha/year
GRIMES ET AL. 1994	Ecuadorian Amazon	Subset of available food & non-food raw materials & medicinal benefits	US\$ 46 / ha/year
		Supply of Protium, a ceramic resin	US\$ 61 / ha/year
ANDERSON ET AL. 1991	Brazilian Amazon	Value to estimates only from the babassu palm tree	US\$ 59 / ha / year
GODOY ET AL. 1993	Mexican forests	Different uses of the Mexican te'lom forest, timber and coffee	US\$ 116 / ha / year
SARAIVA AND SAWYER 2007	Brazil	Various NTFP extracted	R\$ 174 / ha / year

Box 8.9. Xate Palm use in Uaxactun, Guatemala

Villagers from the community of Uaxactún in the Maya Biosphere Reserve (MBR) subsist primarily on income earned from selling NTFP such as fruits, gum, resin, and ornamental flowers, particularly *xate* palm fronds. Over-extraction typical of successfully marketed NTFP, combined with an absence of standards and management practices, resulted in serious challenges to the sustainability of the plant and of the income that its extraction generates.

A communal forest concession signed in June 2009 in this subtropical rainforest community is the first of its kind. Conservation International and the Wildlife Conservation Society (WCS) supported the design of the agreement with the Uaxactún community in close coordination with Guatemala's National Council on Protected Areas (CONAP).

Under this agreement, the community has pledged to conserve 84,000 ha of forest, halt deforestation and cattle farming, protect key species like the jaguar, control fires, use zoning to limit agricultural expansion, abide by transparent business practices, and work with supervision of CONAP. The agreement fosters sustainable use of *xate* with financial and technical support for a nursery to restock forests with *xate*, and with a price premium for sale of the plants.

The government sees the agreement as a potential model for safeguarding the country's natural resources while improving the quality of life for its people. Based on the Uaxactún experience, CONAP is exploring replication of the agreement to implement the National Strategy of Communal Lands, recently approved.

Rainforest Alliance supported villagers in establishing sustainability standards and certification of Uaxactún for sustainable forest harvesting in 2005. Thirty million fronds are delivered worldwide each year for household and church decorations (especially Palm Sunday). The shipments earn more than \$100,000 per year for the community, of which over half goes directly to the 1,300 *xate* collectors. *Xate* exports contribute \$1 million yearly to Guatemala's economy.

8.5 ROLE OF BIODIVERSITY AND ECOSYSTEM SERVICES IN THE FOREST SECTOR

Forest products and services depend on maintenance of biodiversity and ES, while, in turn, these systems support human livelihoods, economic growth, and security. Besides timber and non-timber products, forests provide a wide range of services. For example, they regulate water flows, protect human settlements against landslides and floods, and buffer against climate change.

ECOSYSTEM SERVICES FOR THE FORESTRY INDUSTRY

Most forest-based economic processes require growth of timber and NTFP. These dependencies, in turn, depend on ES inputs, among them water as precipitation and soil moisture, nutrient cycling, soil fertility, pollination and seed distribution, and pest control. Other ES, essential at the ecosystem level, include genetic diversity, waste assimilation, and storm mitigation. Few of these ES can be replaced easily; if degraded, forests may change in character, lose productivity, or be lost. Forests not only use ES but provide many of the same ES for downstream uses. For example, forests not only receive and use water as rain, runoff, groundwater, and vapor, but store and recycle water, providing many essential water-related ES. The same can be said of many other ES: those related to soil fertility, pollination and seed dispersal, microclimate, growth and carbon storage, and biodiversity maintenance are all sustained by healthy forests. These self-operating natural systems are vulnerable to disturbance and degradation, if forests are not sustainably managed.

The Millennium Ecosystems Assessment (MA 2006) offers a framework to analyze types of ES used.

Provisioning Services

Economic benefits from ES in natural and planted forests come mostly from supply of raw materials: timber, fuelwood, and diverse NTFP (ITTO 2007). The provisioning ES that "grow" these materials are exploited by forestry enterprises of varied types and sizes. The raw materials supplied depend, in turn, on provisioning of the plants and animals that produce them with water, nutrients, CO₂, or O₂, and so forth.

Regulating Services

Forest ES are important not only for provision of a variety of inputs to economic processes, but also for regulation of the conditions in which they are provided: micro climate, forest health (vulnerability to fire and to attack from insects and pathogens), and others (ITTO/UICN 2009). Around 330 million hectares of forests worldwide are designated for conservation, avalanche control, sand dune stabili-

Box 8.10. Natura and the Iratapuru, Brazil

Surrounding the Iratapuru State Sustainable Development Reserve, in the Amazon forest in the state of Amapá, the remote Iratapuru community is an exemplary case of Natura's learning from traditional and local communities. The communities had lived off collecting brazil nut for generations, using extraction methods that changed very little. In 2002, major changes were made after an agreement with Natura for the provision of brazil nut oil for the Ekos line.

Composed of 30 families, the Mixed Extraction Cooperative of the Iratapuru River sells crude brazil nut oil to Cognis, a processing company that refines the oil and delivers it to Natura, which in turn uses the oil to manufacture shampoos, conditioners, and bar soap. The community is paid twice, in the beginning of the productive chain, as a provision and for oil sale; and at the end, as a percentage of Natura product sales. To set a fair price for these payments, community meetings were held with participation of family leaders, Natura professionals, and Cognis employees.

All stakeholders presented their needs and expectations, and debated costs, prices, and profit margins. The government of the state of Amapá, NGO Amigos da Terra (Friends of the Earth), and local academic community representatives supported and participated in the negotiations.

Over the course of four years, resources derived from the agreements and from investments made in the community by Natura allowed the construction of an oil extraction plant that the community itself operates. Natura financed the hiring of Imaflora, the Forest Stewardship Council (FSC) representative in Brazil, which certified the plant's nut production with the "FSC green seal" in 2004.

To prevent the community from becoming dependent on the company and to avoid the appearance of a "handout" relationship, part of the value received for the sale of products was allotted to the creation of a Sustainable Development Fund. Its purpose is to foster other economic initiatives by the community to reinforce its technical and commercial management capacity. The community will be in charge of setting its own development goals without the oversight of Natura.

Source: Arnt (2008).

zation, desertification control, coastal protection and production of water, and, soil and water conservation (FAO 2010).

Water and wind regulation: Forests provide clean water by protecting soils against erosion, and recharging streams and groundwater. Forested floodplains act as water storage areas to significantly reduce the level of floods and flood velocities downstream (Anderson and Masters 1993). Healthy riparian areas also act like sponges. When flood waters are slowed, these areas allow more of the excess water to percolate underground. Slow release of stored water from riparian zones helps maintain stream flow between storms. Vegetation slows wave action and roots of trees help bind and stabilize the soil (Anderson and Masters 1993); thus, maintaining forests in high risk areas can buffer against flood and storm damage in coastal and montane sites.

Forests also act as wind barriers, protecting trees and soils and creating appropriate microclimates for tree growth and agriculture. Coastal and others forests buffer against hurricanes and other wind storms.

Pollination and seed dispersion: Many forest plants are dependent on insect pollination in order to fruit and set seed, and, then, on other animals to disperse the seed. In forests, as on agricultural landscapes, hundreds of species used by humans are pollinated by insects, birds, bats, and other animals (Hill 1998). Animals play an equally fundamental role in seed dispersal; for instance, of 172 timber trees in Guyana's Iwokrama forest, 51% are dispersed by mammals and 21% by birds (ITTO/UICN 2009). Maintenance of pollinating and dispersing organisms is part of the regulatory ES of forests.

Such ES can come from small patches of natural forest in human-dominated agricultural landscapes. In Costa Rica, for instance, the oil palm industry is highly dependent on weevils from nearby forests as pollinators (Hill 1998). Despite the clear relation between forests and their own pollinators and dispersal agents, as well as with pollinators of nearby crops, more data is needed to properly gauge the role of this ES in ecosystem functioning, sustainability, and forest productivity, and to identify those ES most at risk.

Biodiversity and genetic resources: Biodiversity is critical to the health of natural and managed forests and plantations. A multitude of different kinds of plants, animals, and microorganisms is essential to maintain healthy, functioning forest ecosystems (Hill 1998). Fragmentation of forests into patches, common on BAU landscapes, undermines biodiversity, with effects ranging from gene pool simplification to loss of species and of ES. Degradation can be lessened by connecting the patches via biodiversity corridors, as by maintaining forests along waterways that connect patches. Fragments are more prone to fires, invasion of weedy species, and habitat degradation (ITTO/UICN 2009). Fragmented forests also lead to increased harvesting costs, because small, scattered stands require more moves by the logger, using more fuel and time.

Forest plantations benefit from biodiversity but also contribute to fauna and flora preservation. Enhancing biodiversity in plantations can be done by increasing variability when plantations are established (Hartley 2002). An obvious way is to use mixed-species plantations rather than monocultures. Random species assemblages are unlikely to be successful; care is needed to design mixtures that are stable and productive (FAO 1992; Montagnini et al. 1995; Lamb 1998). The type and number of species will also be affected by costs. In LAC, a number of native trees have been successfully tested for use in plantations (PROFOR 2010; CATIE 2008), but technical knowledge and seed sources have not been widely available. An economic advantage of building diversity into plantations is that it provides insurance against future changes in biological factors (climate, pests, disease) and in market values (Carnus et al. 2003).

Supporting Services

Soil moisture and fertility are two important aspects of site quality that ecosystems provide to natural forests and plantations. Soil fertility on many rural landscapes in the world is affected by BAU practices and mismanagement of soils. Soils that have been dramatically depleted need costly investments in fertilizers and other amendments to bring them back to productive levels. But, deposition of excess nutrients from plantations may produce acidification and eutrophication, reducing productivity.

Plantation soil fertility under BAU and SEM: Generally speaking, plantation management is associated with significant nutrient losses. In East Kalimantan, Indonesia, Mackensen and Folster (1999) found that on poor Alisols/Acrisols or Ferralsols soils (typical in tropical forests in South America as well), *Acacia mangium* plantations with a harvest volume of 200 m³/ha lost 18% to 30% of the available Ca and K supplies after one rotation. The costs of replacing the expected nutrient losses on intensively managed timber plantations of different species range from 9% to 40% of the plantation's total costs, depending on the species, site management, and type of fertilizer (Mackensen and Fölster 1999).

An average nutrient loss of 20% per cycle would mean that the available supplies of the elements may become limiting in under five rotations. If the area is managed conventionally (using tractors, harvesters, etc. and burning the logging debris), the total loss of nutrients on typical sites after one rotation amounts to 21-62% of the system's pools of K, 9-32% of Ca and 5-20% of Mg, depending on the tree. The losses of P amount to a maximum of 17% and of N (for *Eucalyptus deglupta* only) to a maximum of 53%. The continuous output of nutrients under BAU practices leads to site degradation and decreased productivity.

Using a form of management that preserves the land by not burning the slash and by using methods that preserve the soil (light-weight machines, high-lead cable car systems) and other SEM practices, nutrient losses that occur in each rotation can be reduced by about 50% (Mackensen and Fölster 1999).

The internal rate of return calculated in accordance with government stipulations was 17.7%. If fertility management is geared toward replacing nutrient losses and the plantation's costs, therefore, increase by 13% (replacing nutrients removed with the harvest), the IRR drops to 11%. Investment calculations for plantations, thus, need to consider site-specific effects on nutrient budgets. Managing large, uniform areas conventionally is economically less efficient (Mackensen and Fölster 1999).

Cultural Services

Ingrained appreciation for forest ecosystems and for biodiversity in its many forms is a cultural facet shared by traditional peoples across LAC — and some modern groups too, such as those that support forested watersheds and certified wood products. Certain agroforestry practices traditionally used by indigenous communities in natural forests enhance biodiversity. The clearance of small patches of forest by Mayan families (for example) to cultivate food and fiber, the enrichment plantings of fruit and nut trees, and the harvest and regeneration cycles — all support the growth of more diverse sets of species.

Climate Change Regulation

Climate change will affect the menu of ES available to forest resource users — forest industries, rural communities, and nearby or downstream agricultural operations. Changes in temperature and precipitation patterns will affect distributions of species and ecosystems; increasing storm frequency and intensity will bring greater uncertainty and risk to the users and the forests. Blow-downs, drought, and fires may multiply. Change in fire frequency may affect forest structure, carbon sinks, and air quality. Trees stressed by such factors may be rendered more susceptible to insect attack and/or disease.

The services provided by biodiversity may contribute to long-run profitability of natural and planted forests by providing greater resilience to climate change, as is expected from forest and non-forest ecosystems characterized by varied species and genetic diversity within species. Thus, biodiversity can provide ES in the form of resilience, contributing to maintenance of other ES from forests.

PART II

8.6 COSTS OF BUSINESS-AS-USUAL (BAU)

Forest conversion via slash and burn, then planting open land with high-value monocultures have been constant strategies throughout LAC to bring employment to rural areas. Declining crop productivity on newly-cleared rainforest lands is seen as normal, with ongoing abandonment of old lands and deforestation of new ones to renew revenue streams. Conversion of forests to pasture and cropland, as well as fires associated with the widespread slash-and-burn practices, makes forest loss permanent, with significant reductions in the biodiversity and ES needed by the forestry industry and society.

The Eliasch (2008) Review, commissioned by the UK Prime Minister, found that deforestation worldwide has resulted in a financial loss between \$1.8 trillion to \$4.2 trillion; some researchers put the net present value of forests as high as \$25,000/ha (McKinsey & Company 2008). This section relates the economic losses of forest conversion to the direct and indirect drivers of forest loss and degradation, including subsidies and fiscal incentives, and the impacts on economic and social conditions.

Loss of Soil Productivity

Declining soil fertility of tropical forests, together with unsustainable production practices, soil compaction, erosion, pests, weeds, and pathogens often rapidly diminish the carrying capacity of plantations, pastures, and crops, eventually affecting returns for forest companies and farmers.

BAU farming in the Amazon involves extensive, shifting cultivation of annual crops like rice, corn, and cassava. A piece of forest is logged and burned, then put into annual crops for a couple of years. Burning provides a nutrient-rich, relatively pest-free environment that gives high yields for one-four years. Yields then decline rapidly; copious amounts of fertilizer are required for further crops. That is because in tropical forests, most of the essential nutrients are locked up in the living vegetation, dead wood, and decaying leaves. As organic material decays, it is recycled quickly by the web of living rootlets and their fungal symbionts; few nutrients ever enter the soil, leaving the soil impoverished. On cutting the forest, this nutrient cycling capacity is disrupted, and the nutrients stored in the living tissues are released and lost.

Degradation and abandonment of land was documented in Brazil from 1960 to 1985. By 1985, 14% of Amazonia was converted to agricultural land. Of this, 63% was pasture, 7% annual crops, and 2% perennial crops and planted forest. The rest (28%) was fallow due partly to soil degradation (Andersen 1997).

In contrast, Brazilian states that have promoted agroforestry systems (a SEM practice) on their landscapes have seen productivity raised by as many as three times more cattle/ha compared to BAU-cleared pastures (Brack 2000). Economic analyses (Hecht 1986; Hecht, Norgard, and Possio 1988; Almeida and Uhl 1995) show that ranching in the Amazon had a very low or even negative productivity — if the gains from land speculation were not taken into account — due partly to nutrient loss after a few years. Soil degradation and weeds in Brazil typically reduce cattle stocking rates from two head/ha during a pasture's first four years to only 0.3 head/ha a few years later (White et al. 2001). This six-fold loss in productivity reflects the costs of BAU forest resource utilization, but only in part.

Revenue Loss

Conventional logging, cattle ranching, and agriculture established after forest conversion under BAU, typically, generate few tax revenues or none, since logging fees and other levies are seldom collected. Low tax collection in some countries is a policy to subsidize wood consumption (e.g., as fuel) for social reasons (Fernagut 2008). Illegal logging implies revenue loss from uncollected taxes and royalties in countries that regulate harvesting activities. Loss of timber revenue globally is \$5 billion/year (Fernagut 2008).

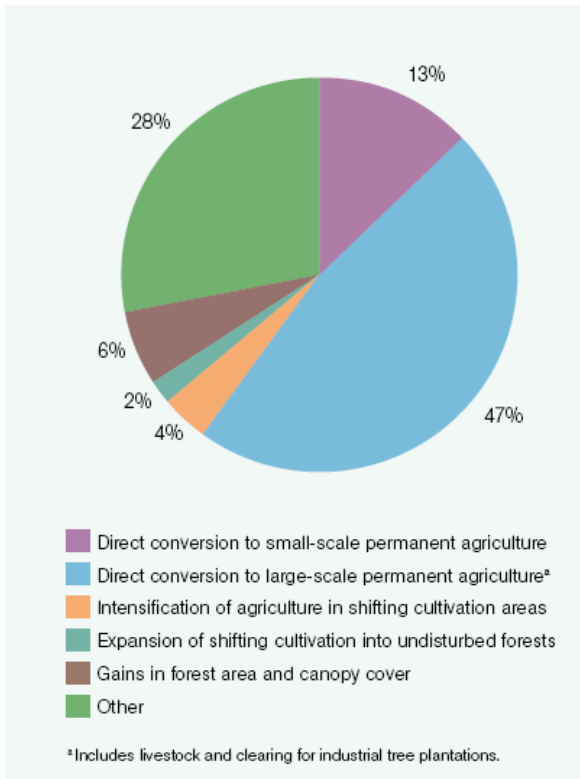
LAND CONVERSION/DEFORESTATION

Depletion of forests in LAC countries is occurring at an alarming rate. This affects the natural resource base on which the livelihoods of rural communities depend. Rural economies remain stagnant. Without investment, the only way to increase revenues is to continue expanding the agricultural frontier, which has led to further stagnation in the past. Land conversion leads to loss of biodiversity and of livelihoods for forest-dependent people, raises greenhouse gas emissions, changes local hydrological patterns (precipitation, flooding, drought), and increases sedimentation and soil degradation (Kanninen et al. 2007).

The main driver of land conversion has been large-scale permanent agriculture, followed by small-scale permanent agriculture (Figure 8.6). Chomitz (2007) summarizes factors that influence deforestation rates:

- The suitability of land for agriculture (flat, fertile, good rainfall, and well drained,).
- Availability of tax credits,
- Accessibility, as by road,

Figure 8.6. Causes of Forest Area Loss in Tropical Latin America, 1990-2000



Source: FAO (2001).

- Fertilizer prices (increased prices bring pressure on forests),
- Demand for agricultural products, farm gate price levels, and
- Situations where land clearing facilitates obtaining property rights, fueling land speculation.

Fire and Land Degradation

Fire is a traditional tool to open up new land to agriculture, by clearing it, killing many pests, and putting the ashes into the soil to enhance its nutrient content. This technique works for a few years but leads to erosion and land degradation because of loss of the soil-retaining and nutrient cycling capacity of tree root systems. Loss of canopy shade leads to an additional degradation factor: heating the soil surface, hardening the surface, and decreased soil moisture.

The risk of forest fires in Latin America is high, particularly in periods of increased drought, like those caused by El Niño in Central America in 1998, when losses in the region were in the range of \$10 billion-\$15 billion (Cochrane 2001). In South America, the incidence of agricultural burning as a cause of forest fires has held steady over decades. Chile is an exception: burning as a cause of forest fires has fallen over 25 years from 41% (1976-1980) to 12% (1991-2000). Key to this was adoption of SEM practices (Alvear 2004).

BAU land conversion methods focus on the short-term economic advantage of burning, while ignoring long-term costs and off-site impacts like nutrient washing, sedimentation, fire risk, and air pollution.

Subsidies

Financial returns from planted and natural forests are a primary factor driving forest management, conservation, and investments throughout the world. The economic activities that exploit natural forests and replace them with other land uses often receive considerable financial support from the public sector. Governments have created a diversity of mechanisms to support forest conversion: direct subsidies, subsidized credit, fiscal incentives, and other forms of transfers. Subsidization of land acquisition also contributes to forest conversion via its influence on land prices (Cubbage et al. 2007).

A large percentage of the world's planted forests have been established with a subsidy of one sort or another at some time, either directly or indirectly (Bull et al. 2006). Direct subsidies in South America, generally, covered about half the establishment costs (Cubbage et al. 2007). Over 75% of establishment costs may be covered when additional subsidies for land, maintenance, and many other costs are considered (Bull et al. 2006). Subsidies generally increase rates of return by 2% to 3% (Cubbage et al. 2007). Subsidies have undoubtedly been key drivers in the rapid growth of plantations.

Subsidies for natural forest exploitation differ from those for plantations. The main subsidy policy tools to promote forestry investment in natural forests are the annual property taxes (Cubbage et al. 2007).

Negative impacts of forestry subsidies: Tax and credit incentives to agriculture and ranching have been fundamental to the expansion of deforestation in LAC (Browder 1985; Mahar 1988; Binswanger 1989). Subsidized credit remains a common incentive for cattle ranching and agriculture (White et al. 2001).

In the Atlantic Zone of Costa Rica, investment in productive land is distorted upward by interest rate subsidies, leading to land speculation, inflated rates of investment in land, larger farm sizes, and higher deforestation rates in agrarian frontier areas. This process is further promoted by subsidized livestock credit and other forms of agricultural subsidy that increase the marginal value of land (Roebeling et al. 2010).

Examination of planting subsidies in Costa Rica and Nicaragua showed only moderate success in promoting establishment tree of plantations, the success of which was significantly diluted by allegations of inequity, inefficiency, and negative environmental effects. Fewer hectares were successfully established than those for which subsidies had been paid: in Costa Rica, only 50% and in Nicaragua, 27% (Bull et al. 2006).

Subsidies also play a significant role in environmental deterioration; on a global scale, subsidies may now be its primary cause (Taylor 1998). A report on perverse incentives to the Earth Council concluded that when prices do not reflect the full costs and benefits of production and consumption, information on scarce resources and environmental values is not properly conveyed, and people act according to erroneous information (De Moor 1997). In forestry, as in other sectors, a non-market price and incentive structure leads to over-investment, over-supply, or overuse and can cause environmental degradation.

There may be circumstances in which subsidies are acceptable: to obtain environmental benefits such as replanting degraded land, providing buffer zones around reserves, and stabilizing watersheds. The circumstances under which such subsidies may be acceptable are likely to be site-specific (Bass et al. 1996). Plantations can provide additional ES such as enhancing biodiversity, reducing salinity, and sequestering carbon. Such benefits should be considered in analyzing subsidization (Pagiola and Bishop 2002).

Mangrove Forest Conversion

Marine and estuarine fauna such as crab, shellfish, shrimp, and fish found in mangrove forests provide income and protein to coastal communities. Mangroves provide timber and fuel, as well as many NTFP and ES, such as storm protection, drainage and filtration, wind breaks, and fresh water (Gammage 1997).

Mangroves in the Caribbean are critical to mitigate the effects of tropical storms, acting as natural barriers to winds, storm surge, and other coastal weather hazards. In areas prone to storms, mangrove disappearance increases impacts on coastlines, and the cost of recovery, reconstruction, and relocation of people.

Mangroves are essential to the shrimp industry; deforestation and agrochemical run-off directly impact shrimp breeding grounds, slowing productivity and lowering yields (see Box 8.11). In El Salvador, this industry adds about 3.8% to yearly export revenues. Some 112,000 families depend on 26,772 ha of mangrove and brackish forests (MIPLAN 1993; Paredes et al. 1991; Foer 1991 in Gammage 1997).

8.7 NET ECONOMIC BENEFITS OF SEM

This section analyzes the economic benefits of SEM in areas related to forest resources production and certification, return on investment, and economic benefits of mixed plantations vs. monocultures. Different types of forest resource users (listed in Table 8.1, earlier) have distinct costs of transition from BAU to SEM. Smallholders who occasionally sell timber or NTFP in low volumes, may find shifting to certi-

fied SEM practices costly and the net economic benefits unclear. For medium-sized operations, market access and new revenue-generating options may be an incentive to engage in SEM practices, particularly if several producers get together to make SEM certification affordable. Large-sized operations will find SEM practices requisite for market access; certification costs will be low due to economies of scale.

REVENUES FROM SEM PRACTICES

Revenue from sustainable activities related to forest management and recovery in the northwestern Amazon may have reached \$123 million, as early as the decade 1982-1991 (Arias 1994). GTZ's Project Gesoren in Ecuador's Amazon estimated the benefits from avoided costs of deforestation at \$3 million, while the costs of forestry control were \$112,000/year (Hexagon Consultores 2007).

Avoided costs from protected areas and SEM practices can also be calculated by valuing the ES from forested areas. In Peru, the economic value of carbon sequestration on 2.4 million ha, 92% forested, was \$1.25 billion in 2000 with a projected value of \$2.47 billion in 2010 (Chambi 2002). The total economic value of the biodiversity hosted by the area was found to be \$1.85 billion in 2000. This figure includes associated benefits such as fishing, NTFP, timber, agriculture, ecotourism, gold, and carbon sequestration, together with option and existence values.

In Peru, sustainably-managed timber concessions were shown to be profitable by analyzing net present values and internal rates of return from six concessions (Table 8.8). IRRs ran 24%-74% (González 2005).

SEM, Certification, and Market Access

New trends in market response to the status of natural forests require that forestry industries in LAC adapt adeptly. For example, origin denomination in agricultural products such as "bird friendly coffee from

Table 8. Profitability in selected Sustainable Managed Timber Concessions in Ucavali Peru

TIMBER CONCESSIONS	MPV	IRR
Concessionaire 1	37,904	24%
Concessionaire 2	108,894	34%
Concessionaire 3	518,410	74%
Concessionaire 4	461,085	56%
Concessionaire 5	289,148	42%
Concessionaire 6	264,157	35%

Source: González 2005

Box 8.11. Impact of Logging in Mangrove Forest in Barra de Tecoaapa, Mexico

Degradation of mangroves threatens livelihoods of coastal populations in several LAC countries. In Mexico, urban development, agriculture and ranching, aquaculture, and pollution are pushing fisheries that depend on healthy mangroves to the brink of collapse. Mangrove felling continues, reducing productivity and impacting fisheries.

A study undertaken in Barra de Tecoaapa on the Guerrero coast measures how much economic harm (loss in net benefits), via environmental damage and degradation of ES, was caused by deforestation of 3.5 ha of mangrove forest to plant maize in a community along the Quetzala river from June to November 1992 (Hernandez et al. 2000).

Litterfall production: Before deforestation, 14.2 ton/ha/year of litterfall (dry weight) was deposited on the forest floor. In terms of units of organic carbon, an estimated 7.8 ton C/year, previously deposited in the 3.5 ha, was lost to the system. Part of the organic matter produced by mangroves is exported to the sea where it goes into the trophic chain; 10%-15% of this is transformed into fish, crustacea, molluscs, polychaetes, and isopod tissue. Of that fraction, no less than 20% is caught in commercial fisheries (Odum 1970 in Hernández et al. 2000). Thus 1.9 tons of live tissue of a variety of organisms would have been obtained from the lost carbon, and 380 kg of fish, crustaceans, and mollusks were not caught at sea the following year. At an average of \$1.26/kg, the fishery's value shrunk by \$480.

Recorded environmental changes: On the study site, accelerated salinization occurred in December 1992, together with an increase in temperature. Interstitial salinity in the soil went from an average of 12 psu (practical salinity units) in the forest to 30 psu in the deforested area. Lack of plant cover caused temperatures to rise by up to 13°C in soil and 11°C in the air (Hernández et al. 2000).

These variations induced changes in soil color, permeability, and density. Permeability rose via lixiviation and decomposition of organic matter, increasing the portion of sand from 43% to 63%. Strong changes in atmospheric and soil humidity were observed.

Economic losses: After deforestation, maize was planted from June to November 1992 yielding an average of 529 kg/ha valued at \$0.45 cents/kg, which left farmers with a total of \$68, net of expenses (labor, planting, and weed and pest control). In 1993, the site was planted again, but the yield decreased to 190 kg/ha of maize, at a market price of \$0.60 cents/kg leaving a net income to farmers of \$20. In 1994, the site was abandoned.

Felling 3.5 ha of mangrove forest produced a loss to the community of wood for construction and firewood, with an estimated cost of \$80/ha/year. Between 1993-94, a 33% reduction in estuarine fisheries occurred, primarily because of the destruction of the refuge, reproduction sites, and fishery areas for species along 200 m of the felled river margin. The loss of the mangroves also caused silting of the deepest part of the river (2.5-4 m), used as a refuge by commercial fishing species. This was particularly critical in 1993. The fishery yield of 1991-1993 was averaged, and the average for each species was multiplied by the price of the kilogram of fresh product in the market and compared to the 1994 yield. Losses for the community were recorded as volume and income for the years 1993 and 1994. While other factors may have affected catch size, records show a decrease from 5,305 kg to 4,244 kg of fresh product for 1993-94, worth \$1,758 and \$2,030. Catches recovered by 15% and 17% in 1995 and 1996, except for snook, but never reached the 1991-92 yield.

Other benefits such as harvesting honey and wildlife were also analyzed; net costs were included in the table below. It is estimated that the costs incurred by felling this site were 32 times higher than the benefits obtained by the farmers.

COST-BENEFIT data expressed in \$

Products and services	Costs (USD)	Benefits (kg of maize)	Income USD
Extraction of wood and firewood	136.0	1992 cycle...1850	67.6
Estuarine fisheries	1895.0	1993 cycle....665	20.4
Marine fishery component	480.0		
Wild fauna	133.0		
Honey	162.0		
Total	2805.0 USD	Harvest 2515 kg	88.0 USD
Costs after 5 years+55% ¹	21 741USD		

¹ Costs for the five years during which the site recovered by only 30%, plus the average inflation recorded during the same period.

Costa Rica” is gaining more acceptance in international markets. The same applies to certain types of timber and NTFP products.

There is growing concern by consumers about the state of forests and how purchasing patterns may affect forest conditions. Certification by FSC or Programme for the Endorsement of Forest Certification (PEFC) can contribute widely to SEM and has become an increasingly important tool for accessing or assuring markets. Certification emerges as a way to counteract market, institutional, and governance failures, opening the door to new market niches for certified forest products.

In Guatemala, FSC-certified community concessions increased their revenues by 209% to \$5.8 million. Improved sawmilling efficiency, higher grades of mahogany, better prices for FSC-certified mahogany, and the addition of an FSC-certified NTFP made higher revenues possible. In addition, employment for women in associations increased, by working on value-added NTFP business (PROFOR 2010).

In Honduras, cooperatives banded together to provide semi-processed mahogany for export to certified markets by changing their production chain and adopting SEM practices. With only a 19%

increase in volume harvested, their revenues increased by 128% to \$579,375 after accessing certified markets. Production costs rose 40% due to increased costs of forest management and taxes, as well as the extra care needed to produce quality mahogany grades (PROFOR 2010).

Despite the potential of certification to expand forestry businesses and to support SEM, its adoption has lagged. By 2007, only 1.2% of the forest area in LAC was certified, up from 0.4% in 2002. The region’s share of certified area was only about 4% of the world’s total (ITTO 2008). According to FSC, certification in 19 countries of LAC accounted for 11.7 million ha in 679 operations (Table 8.9).

Three main factors have hampered growth of certified forest management programs (Durst et al. 2006): (1) an absence of premium prices for certified wood in some markets, (2) a wide gap between existing management standards and certification requirements, and (3) a weak ability to formulate appropriate forest sector policies and ensure effective implementation. Additional barriers are insufficient capacity to implement SEM at the unit level, to develop standards and delivery mechanisms, and to resolve land tenure issues.

Table 8.9. Number of FSC Certifications and Area Under Forest Management in LAC

	NUMBER OF CERTIFIED OPERATIONS				AREA (HA) IN CERTIFIED PROJECTS		
	COC	FM	FM/COC	CW/FM	FM	FM/COC	CW/FM
Argentina	18		14	1		256,331	120,560
Belize	1						
Brazil	252		64			5,474,587	
Bolivia	28		18	1		2,093,158	
Chile	32		13			313,590	
Colombia	4		2			20,361	
Costa Rica	11	2	17		1,060	66,880	
Dominican Republic	0		1			1,000	
Ecuador	0		4			24,537	
Guatemala	8		10			481,967	
Guyana	3		1			371,681	
Honduras	6		4			16,175	
México	21	1	36		965	717,446	
Panamá	3		7			13,715	
Paraguay	3		2			15,974	
Peru	19		8			628,359	
Puerto Rico	3						
Uruguay	25		33			916,690	
Venezuela	2		1			139,650	
TOTAL	439	3	235	2	2,025	11,552,101	120,560

Similar interest in certification standards and sustainability criteria is expected to arise in economic activities that can compete with forests for land, such as biofuels, beef, and cereals. Examples of this are the Roundtables on Responsible Soy Association, Sustainable Palm Oil, and Sustainable Biofuels, with active involvement of several countries in the LAC region. These organizations include all players on the custody chain and use social, economic, and environmental criteria to guide production activities. Certification for sustainable management, conservation of biodiversity, and social welfare is being used by actors in these value chains as a strategy to gain market access and as a way to enhance competitiveness.

Trade bans and other import restrictions tend to be used against products that become associated with unsustainable extraction. For instance, the European Union (EU) launched an action plan to restrict the illegal timber entering the EU, raising the import requirements on tropical timber (Commission of the E. C. 2003).

A recent trend among sustainable forestry certifiers is to actively approach small- and medium- forest enterprises (SMEs) in developing countries. They account for as much as 80%-90% of businesses and many large-scale forestry companies are already certified. This can help formalize forestry practices in community and other small forestry initiatives, modernizing the sector at that level. Accounting for 50% of forest-related jobs and offering a greater leverage to reduce poverty than large-scale operations, SMEs are a model for new forms of rural institutions, such as community enterprises (Rainforest Alliance n.d.).

Native Species and Mixed Plantations

By using native species, it is possible to replicate the high quality of timber found in original rainforests, serve local markets with familiar woods, and, often, improve growth rates (PROFOR 2010). Native biodiversity is supported and it is possible to create natural corridors between forest patches (Erskine et al. 2005). Erosion risk is reduced and nutrient use increased because of the complementary root architecture and soil use strategies of distinct species (Ewel and Putz 2004). Increased growth of mixed plantations is due to lower levels of intra-specific competition in mixed plots. Mixed plantations have proved to be more resilient to pests, diseases, and climatic variations. Selection of appropriate species is important to design more productive mixes (Piotto et al. 2009). Alien species, if not threatening to surrounding ecosystems, can be used to good advantage, if they provide essential ecological or socioeconomic services. By speeding restoration or making it more effective, non-native species can provide economic and ecological payoffs (Ewel and Putz 2004). Mixed plantations better accommodate the immediate economic necessity of many smallholders who need to begin harvests prior to completion of the rotation. Mixed plantations may often be a preferred system for reforestation, either for timber production or carbon storage because a mix is more economically viable and productive than single species antings (Piotto et al. 2009).

Return on Investment – Mixed Plantations vs. Monoculture

Studies in Australia and Costa Rica show the economic benefits of reforestation using a mix of native species instead of monoculture. Mixed plantations yielded more timber per hectare with a Net Present Value (NPV) of \$1,124 to \$8,155/ha and Internal Rate of Return (IRR) of 7.7%-15.6%, depending on the species mixture (Lamb et al. 2005). Mixed plantations also performed better for all growth variables considered, including height, diameter, volume, and aboveground biomass (Piotto et al. 2009).

REDUCED IMPACT LOGGING (RIL) VS. CONVENTIONAL LOGGING (CL)

RIL has been shown to be more competitive than CL in financial returns to initial harvest entries. CL operations refer to unplanned, selective harvesting where salable stems are identified by a skilled timber cruiser, felled by a sawyer, then later searched for by tractors or skidders, and extracted on impromptu skid trails to log decks or roadsides, generating considerable environmental impacts (Boltz et al. 2003).

RIL requires investment in inventory, planning, vine cutting, and infrastructure up to a year before logging, equal to 2%-18% of total CL harvest costs. The pre-harvest costs of RIL are a disincentive to its adoption. However, RIL direct costs are usually lower than or competitive with those of CL due to gains in efficiency and reduced wood waste (see Box 8.13). Lower indirect costs were obtained under RIL due to gains in efficiency that brought lower support, maintenance, and overhead expenses relative to CL.

RIL methodology defines the pattern and intensity of harvesting, and the resulting opportunity costs relative to CL. When RIL is designed to mimic CL harvesting in terms of harvest level, species, size classes, and spatial distribution, gains in operational efficiency and waste reduction makes RIL environmentally and economically superior to CL, as shown by comparative studies on CL and RIL in Brazil, Guyana, and Ecuador (Boltz et al. 2003). Direct and indirect costs of RIL vs. CL in the examples studied reflect the potential for adopting RIL practices (Figure 8.7). These costs are not adjusted for waste, therefore, the relative costs of RIL may be even lower and the comparison with CL even more favorable (Boltz et al. 2003).

Despite the overall benefits and profitability of RIL, an obstacle to its wider adoption is the uncertainty concerning the marginal benefits of RIL in relation to the more familiar, known profitability of CL (Boltz et al. 2003). CL firms face few incentives to alter their operations unless dramatic changes in market signals appear. Current stumpage and timber prices may not provide incentive to adopt practices that appear more costly up front. If stumpage fees do not reflect the true value of the assets or if land and forest resources are treated as a “free good,” they will be over-utilized and RIL will be less competitive. This appears to be occurring in areas of South America currently under intensive timber exploitation (Boltz et al. 2003).

Box 8.12. case study: planting empowerment — private business model for local reforestation

Background

Planting Empowerment (PE) is a private firm committed to socially responsible activities, addressing environmental, social, and economic means to attain the goal of conserving rainforest in Panama's Darien Province. Its business model engages rainforest-dependent populations to create investment opportunities in sustainable forestry and increase conservation in fragile environmental areas. Darien province is recognized by Conservation International as a threatened biodiversity hotspot. After being logged, the land is typically used for agriculture or pasture, during which time the land loses fertility from overuse and poor management.

By leasing previously deforested land from low-income landowners in the Darien, PE reforests the area with a mix of predominantly native specie tropical hardwoods. After a 25-year cycle, the trees are harvested for investors (including local communities) and the surrounding biodiverse forest is left to continue attracting species and enriching the environment. US and European investors who desire a solid return, as well as a positive social and environmental impact, partner with PE. Incorporated in Panama in January 2007, PE has already planted 22,000 trees in mixed species plots on 20 ha of previously denuded and degraded land.

BAU

Nuevo Paraiso, one of PE's partner communities in the Rio Congo region of Darien settled in the 1980s by Latinos, now has a population above 20,000. The majority depend on exploiting natural resources (principally land) for a livelihood. Smallholders often obtain land by squatting on a parcel of rainforest, then logging and clearing the land to make room for subsistence agriculture and, later, cattle. According to FAO, Panama lost about 82,000 ha of rainforest between 1990 and 2005. Cleared land around the community sells for \$200-\$3000/ha depending on road access, power connection, and cleared vs. semi-cleared status. Landowners currently rent pasture at \$14/month for 9-10 months/year. They can also plant corn or rice that yields \$200/ha using slash-and-burn practices, but this practice requires crop rotation and resting the land at least five out of every ten years.

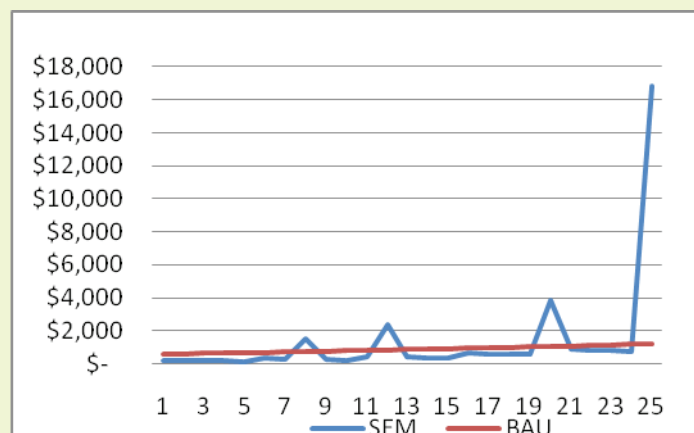
Taking into account the opportunity cost over 25 years, as well as the investment in the land, an IRR of 6.24% does not seem unreasonable for a landowner rate of return under BAU conditions. However, in addition, slash-and-burn and cattle raising practices cause erosion, soil compaction, and loss of fertility that further degrade the property, in effect, limiting the holder's future returns. Agriculture and ranching produce only sporadic income from har-

vests or sales of cattle. There is currently no incentive for smallholders to invest in conservation of natural resources.

SEM

The vision of the company is to (1) increase and smooth the income smallholders receive, and (2) do this by undertaking activities that promote regeneration and conservation. The company leases degraded land from locals for between \$13.66 and \$18/ha-month. This rate is set for the first five years and then scales each five years for the full 25 years, to match potential inflation. Thus, landowners receive a guaranteed increase in return of between 15%-80% plus income smoothing due to year-round lease payments (agriculture and renting of pasture stop during dry season). Finally, landowners receive 2%-4% of revenues generated from the plantations on their land (profit sharing). In both BAU and SEM cases, the land is valued as an initial investment of \$12,500 (\$2,500 x 5ha).

Figure 1. Individual Yearly Economic Return, SEM vs BAU



According to the PE SEM table, the profit-sharing lease payments after the initial investment over 25 years offers a SEM IRR of 11.24%, significantly higher than the BAU IRR of 6.24%. PE is partnered with two landowners in Nuevo Paraiso, each leasing 5 ha to the project. Binding contracts grant PE access to the land for 25 years. Monthly lease payments are made to partners through a savings cooperative an hour away. By making conservation more profitable than normal slash-and-burn activities, the company gives smallholders the incentive to maintain their natural resources (Figure 1)

Community and Landowners of Nuevo Paraiso

To better examine the benefits that PE's SEM offers over the BAU case, the community and landowners of Nuevo Paraiso offer an example. Table 1 lists the benefits to both parties from profit-sharing with PE.

Table 1. Benefits in Monoculture vs. SEM

	Monoculture	PE (SEM)	Comments
Daily Wage	\$10	\$10	Detail variety of local work for \$10
Sale of Land to Project/ha	\$2,000	\$4,000	On average
Equity in plantation - individual	0	4%	Potential value of \$4000/ha over 25 years
Equity in plantation - community	0	2%	Potential value of \$2000/ha over 25 years

Scholarships, other community help (latrines, water systems, etc.)

Source: Planting Empowerment (2010).

Table 2. Comparison of BAU with Cattle or Subsistence Farming - Individuals

	BAU	PE (SEM)	COMMENTS
Daily wage*	\$8	\$9	BAU wage is paid to work as manual laborer for 7 hours with machete
Salaried worker	\$200	\$300	\$100 salary difference, plus benefits
Cattle ranching	14	\$13.68 - \$18/month	
Equity in plantation	0	2% - 4%	valued at \$4000/ha over 25-years

Source: Planting Empowerment (2010).

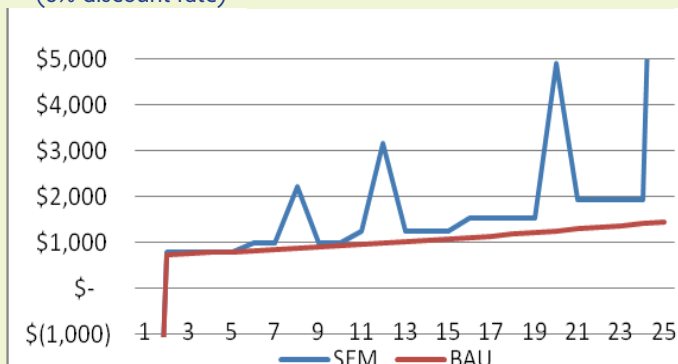
PE estimates that additional revenues will be generated through carbon credit profit-sharing with the landowners (Figure 3). At 6t/yr of storage, plantation forests are more efficient at sequestering carbon than natural forests.²⁶ Carbon credits in the voluntary market are at about \$4/t in the US (\$12/t in Europe), but are expected to rise as energy consumption increases and the US develops its carbon credit market.²⁷ One ha of PE’s mixed species plantation will store 6t/yr of

Other benefits arrive with the increases in local labor employment. Although the initial increase in employment is minimal (structural change), larger benefits to the community will accelerate once small industry develops in the region, adding value to the timber produced from the plantations.

The last harvest at the end of the plantation’s cycle provides most of the profit-sharing revenues (Figure 2).

The company also pays a premium to its day laborers (\$9/day vs. \$8/day) compared to other wage opportunities in the area. The full-time foreman that PE employs receives a salary of \$300/month plus benefits (health and pension). As the government sets the minimum salary at \$200/month (without benefits), PE pays roughly a 50% premium (Table 2).

Figure 2. Net Present Value by Year, SEM (PE) vs. BAU (8% discount rate)

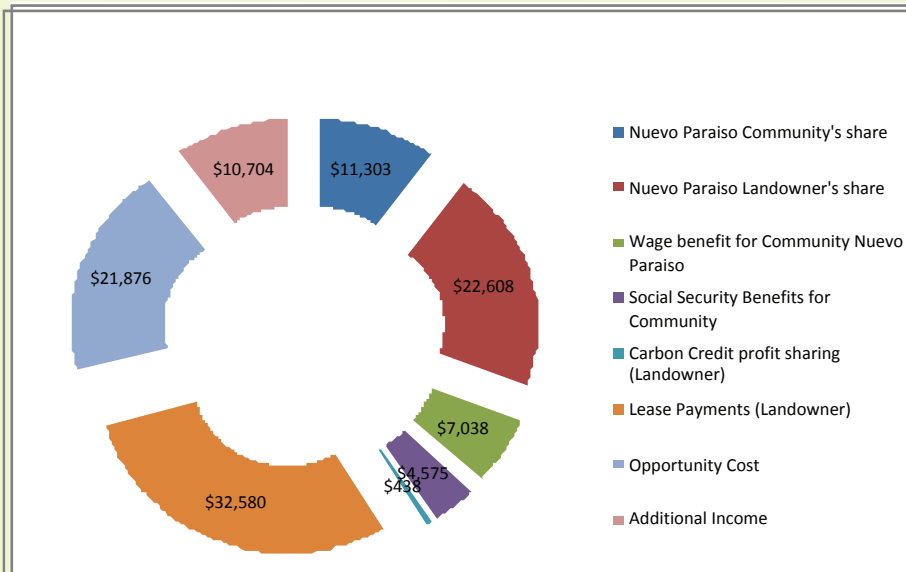


carbon, nearly enough to offset one American’s yearly carbon emissions of 8t. A 20 ha plantation is expected to sequester roughly 3000 t of carbon over the 25 year investment span. In the table, a small yearly profit from the sale of these carbon credits will be realized by the landowner as well.

26 Potvin (2008) measures carbon sequestered by 1 ha of Teak at 350t/ha over 20 years. PE assumes under 50% of the 350t over 25-years, or 6t/ha/year.

27 <http://www.chicagoclimatex.com/about/program.html>

Figure 3. Community/Landowner Nuevo Paraiso Case (25-year Plantation)



To calculate the Net Present Value of the Individual Landowner, as well as the Social NPV for the community, the opportunity cost of the land (rental for cattle) is subtracted from the lease payments they would receive from PE in order to calculate the additional income generated from the SEM over the BAU case. Totaling all three categories, using an 8% discount rate (equal to local livestock financing interest rates), the NPVs are all positive totaling over \$10,000 on 5 ha of land for the total and the community, as well as over \$8,000 for the individual landowner.

Other Benefits

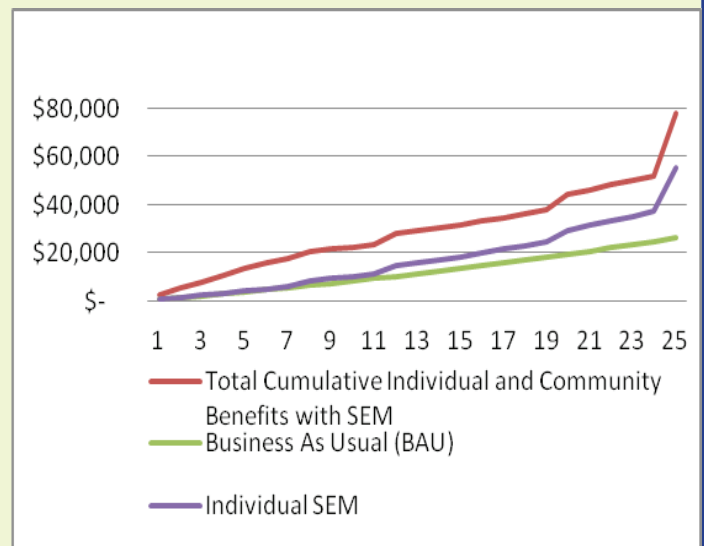
Most of the population, including settlers and indigenous people, depend on the exploitation of natural resources for a livelihood. By exhausting the land's fertility, low-income settlers lose their chief source of income, pushing them into deeper poverty. Those who purchase new tracts of forest to work continue the cycle of slash-and-burn agriculture as a short-term answer to the lack of sustainable income. The PE solution to this is to lease – not buy – degraded portions of their land and pay them for the opportunity cost (cattle, subsistence agriculture) via lease payments. The landowner keeps the property, which appreciates, still has a portion of it to work, and receives a steady income.

Because PE plants approximately 70% native species, this culture choice will help ensure biodiversity maintenance and soil fertility. PE plantations include eight to ten different tree species, while leaving many non-commercial species, with the potential for many more if conditions permit. This mix of species attracts a healthy diversity of flora and fauna, providing forest corridors for species to travel between “islands” of jungle.

The tree plantations are helping to protect virgin rainforest in two ways. First, the PE does not displace low income landowners and, therefore, does not encourage them to venture farther into the jungle to clear new plots. Instead, the leasing model pays them monthly to stay on and conserve their land. The “normal” model employed by plantation companies is to purchase land from local communities/farmers. Often, these quick sales result in reinvestment in a larger tract of forested land, which would subsequently

be logged and degraded. Second, as the plantations begin to produce timber, it will offset or decrease demand for old growth timber. The plantation timber will be FSC-certified, a feature that large purchasers like Home Depot and Ikea now require. The organization of plantations makes their future timber production easier to manage than that of an old growth forest, where low accessibility increases extraction costs and damage.

Figure 4. BAU vs. SEM Benefits in Dollars



Source: Planting Empowerment (2010).

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Box 8.13. ROI from RIL: Return on Investment from Reduced Impact Logging

At Fazenda Cauaxi in Brazil's Amazon, a comparative analysis showed the benefits of RIL over CL. Pre- and post-harvest inventories showed RIL to be effective in reducing wood waste in the forest and on the log deck.

- Wood wasted in the CL operation was 24% of the initial harvest volume, compared to only 8% with RIL.
- More careful checking of logs under RIL increased recovered volume by 1.1 m³/ha relative to CL, and better coordination between felling and skidding crews in RIL increased recovered volume by 0.9 m³/ha.
- More careful tree selection by RIL crews (in terms of size, species, and defects) resulted in a decrease of about 1.4 m³/ha in logs that were harvested but not used by the mill.

Logging damages the residual stand. In contrast to CL: by cutting vines, directionally felling trees, and planning the layout of roads and skid trails in RIL operations, damage to commercially-valuable residual trees can be greatly reduced.

RIL reduced fatal damage to residual trees: for every 100 trees felled on the CL block, 38 (commercial, greater than 35 cm dbh and with good form) were fatally damaged, compared to only 17 in the RIL block.

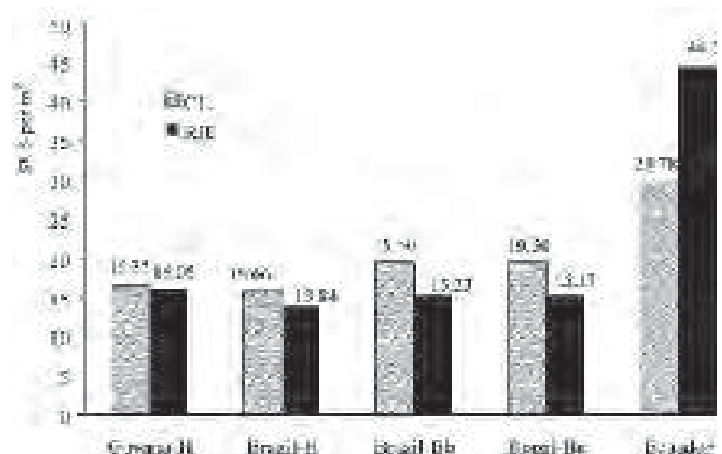
- Damaged future crop trees in the residual stand were recovering at nearly twice the rate on the RIL block.

RIL due to gains in efficiency that brought lower support, maintenance, and overhead expenses relative to CL.

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Figure 8.7. Direct and Indirect Costs of CL and RIL



Source: Boltz et al. (2003).

8.8 MARKET OPPORTUNITIES FOR SEM

In Central America, it is common to find forestry operations that are working with no net profit or at a loss, due to lack of information of the operators — mainly small scale, community enterprises — on the costs involved in the extraction. Certification standards that adopt RIL practices are able to solve this problem by incorporating registries, inventories, and both extraction processes and standards that help attain profitable margins (Butterfield 2010).

With no constraint on land availability, no clear signals of scarcity, and no effective regulatory framework, loggers will likely not be drawn to the marginal increments in efficiency to be gained under RIL. In a broader landscape without resource constraints, the opportunity costs of more careful RIL management, relative to maximizing forest turnover and timber processing by conventional means, may be too high and the benefits too uncertain for firms to change their logging behavior.

Forest Governance and Tax Revenues

Revenues from royalties, fees, and taxes from timber and forests remain very low in LAC (May et al. 2003; Richards et al. 2003). Governments, generally, spend more on forestry than they collect in revenue. This situation undercuts public finance and support for transitioning to SEM, and also reinforces treatment of forest resources as free goods, sending the wrong market signal and encouraging continued BAU practices. On the other hand, where taxes and fees are attractive, public agencies have an incentive to assure that logging and extraction activities are carried out in a sustainable way to maintain the revenue stream.

The average governance expenditure per hectare in South America was less than \$1 compared to Asia at \$20 (FAO 2010). In contrast, countries like Cameroon raise substantial revenues from timber auctions and taxes, with forestry providing up to 25% of the country's total tax revenues (Fernagut 2008).

The problem in LAC is worsened by the lack of governance in control of forest resources and the low prices associated with overexploitation of forest resources on the agricultural frontier. Often, the removal of commercially valuable trees is used to pay loggers for the cost of land clearing. In contrast, if taxes and charges on timber were set appropriately in a proper governance system, sustainable logging could become a pole of economic dynamism and SEM for natural forests would be more feasible.

Better forest governance will halt fiscal losses due to corruption, with uncollected taxes and royalties on legally-sanctioned timber harvests. If a fair level of tax on forest resources is achieved, this condition can lead to improved compliance with other environmental directives, raising revenues for environmental monitoring and enforcement, and benefiting equitable development initiatives (Fernagut 2008). Taxes can also be used as a disincentive to over-capacity in logging, thereby reducing over-investment in the forestry sector.

Besides wood products and NTFP production, with certification to foster sustainability, there is also a huge potential for the region to capitalize on existing and emerging ES markets for PES including carbon sequestration, biodiversity, and watershed services markets.

PAYMENTS FOR ENVIRONMENTAL SERVICES

Payments for environmental services (PES) have mainly been used for watershed services. They are emerging as an alternative to command and control measures for forest management in several places. Globally, direct and indirect PES combined are about the same magnitude as total annual investment in forest conservation by governments, philanthropic organizations, and international organizations — somewhere between \$2 billion and \$2.5 billion/year (Scherr et al. 2004). Most LAC countries have legislative and regulatory frameworks for forestry, natural resources, or water to promote use of economic incentives for forest production and protection. By 2008, at least 22 countries had engaged in PES projects or in studies to implement one; payments for watershed services in LAC accounted for \$555 million, conserving 8.9 million ha. Payments in LAC to farmers for carbon sequestration have totaled roughly \$137 million, while conserving 1.08 million ha between 1993 and 2007 (OAS 2009).

A well known example is Costa Rica's PES scheme. Landowners who protect forest cover receive payments from the National Forestry Trust Fund, averaging \$40/ha/year. Funding comes from a fuel sales tax, supplemented by "environmental credits" sold to businesses and other international sources (see Box 8.14).

Another PES example is Mexico's Program of Hydrological Environmental Services (PSAH). This program began in response to rapid depletion of aquifers, where two thirds of the 188 most important aquifers suffered from over-allotment of water resources. On average, extraction for human use was nearly double the natural recharge rates (Ruiz-Perez et al. 2005). The PSAH, which combines forest and water policy, provides incentives to avoid deforestation in areas with severe water shortages. With this program, the Mexican government pays forest owners for watershed protection and aquifer recharge in places where commercial forestry is not currently lucrative. Funded by \$18 million in federal water fee revenues (Munoz-Pina et al. 2008), the program selects beneficiaries — landowners and populations — by criteria that include the value of water and the degree of poverty in the affected area. In 2004, 83% of payments went to marginalized population centers (Ruiz-Perez et al. 2005). PSAH payments have also been channeled to implement

Box 8.14. Case Study: Payments for Environmental Services: the PES Program's Impact in Costa Rica²⁸

Costa Rica's PES program started in 1996, with origins in earlier attempts to incentivize forest conservation. Launched as Costa Rica's response to the agreements attained at Rio and in the Climate Change Conventions, the program is managed by the National Forestry Financing Fund to provide "financial recognition by Costa Rica's government to forest and plantation owners for the environmental services they provide and their impact on environmental protection and improvement" (FONAFIFO 2010). Current law allows people to apply for PES in seven categories: (i) forest protection, (ii) forest management, (iii) reforestation, (iv) established plantations, (v) agroforestry systems, (vi) natural regeneration with productive potential, and (vii) natural regeneration in pasture areas.

Scholars have undertaken to evaluate from different angles the impacts of Costa Rica's PES since it began. There is evidence on the motivations people have to enroll, as well as on the program's impacts in terms of deforestation rates and poverty reduction. While the goal is to incentivize forest protection and regeneration, the reasons given for participating are varied and do not always respond to conservation efforts.²⁹ However, the reasons to join the program are not that important, as long the goal is attained.

One main factor that prevented people from enrolling in the program is the low profitability of the payments compared to other alternatives, especially considering the application costs. Between 1996 and 2000, for instance, the average payment ranged between \$22 and \$42/ha but participants had to pay for a management plan that accounted for about 15% of the payment.

Table 1. Costa Rica: Summary of Findings on the Relation Between the PES Program and Deforestation Rates

Author	Region	Period	Positive Impact
Zbinden and Lee	Northern Zone	2005	PES recipients had 61% of the farm under forest, compared to 21% for non-recipients
Sierra and Russman	Osa Peninsula	2006	PES recipients had 92% of the farm under forest or bush, compared to 72% for non-recipients
Ortiz and others	NA	2003	36% of forests with PES contracts had previously been used for pasture
Tattenbach et al. in Tattenbach, Obando & Rodríguez	Cordillera Volcanica Central Conservation Area	2006 to 2006) 2000	in 2005, primary forest cover nationwide was about 10% greater than it would have (analyzes been without the PES program
NA	Sarapiquí	2006 (analyzes 1997 to 2000)	PSAs encouraged protection of mature native forest
Sanchez-Azofeifa et al.	Country	2007	Deforestation rates in areas not receiving payments were not significantly higher than areas that were enrolled in the PSA program
NA	Country	2007	PSA program had only minimal impact on deforestation in first phase

Source: Mayer not dated

Independent of the net effect of the PES program on deforestation rates, Costa Rica has indirectly achieved other important milestones related to increased competitiveness of the tourism sector and poverty alleviation. Some findings are summarized in Table 2

²⁸ Prepared by Adriana Chacón-Cascante (2010), CATIE, Costa Rica.

²⁹ The program has been highly evaluated, apart from the motivations participants might have to enroll. Among the reasons expressed by applicants as factors in their decision to join are lack of more profitable land-use options due to land characteristics (e.g., poor soil quality); legal restrictions on forest management on steep slopes or near streams and against land use-change; low returns of alternative activities such as cattle farming; earning extra income; and income for people with physical limitations that restrict their ability to work (Arriagada et al. 2009).

Table 2. Costa Rica: Summary of Research Findings on Other Indirect Impact of the PES Program

Author	Period	Positive Impact
Segura et al;	1997	Job creation, particularly for women and local peoples, and better soil quality
Rosa et al.	1999	
Pagiola	2006	Tourism sector growth: Costa Rica established itself as a global leader on environmental issues. Growth due in part to country's position as one of the world's most environmentally conscious countries; In 1995, tourism revenue was \$681 million and it increased to \$1.57 billion in 2007
Ortiz	2003	Poverty alleviation: PES represented over 10% of total income for over 25% of the participants
Muñoz	2004	Poverty alleviation: Payments to PES participants under the poverty line moved about 50% of them above this edge

Source: Bennett and Henninger (2008).

Despite that, Costa Rica's PES program has proved to be successful in many ways. Carlos Manuel Ramirez, former Environment Minister, states that it "transformed conservation from charity into an economic tool capable of competing with any other export in the global marketplace.... We proved a developing country can succeed using conservation as an economic engine," and that "an acre of forest is worth more than a cow" (Tidwell 2006). Jorge Mario Rodriguez, FONAFIFO Director, declared that the PES program has "not only contributed to the socio-economic development of beneficiaries in the rural sector, but they have also had a visible environmental impact, which is reflected in a reduced deforestation rate and an increase in the country's forest cover." (Mayer 2009).

Since the program's inception, deforestation rates have dropped significantly. It is important, nonetheless, to consider other factors that might have pushed deforestation rates down. A few researchers concluded that many landowners had preserved their lands or had adopted more environmental friendly practices, whether or not they had received PES (Ortiz et al. 2003 and Miranda et al. 2003 in Mayer 2009). There is an ongoing debate on whether Costa Rica's PES program is actually a main determinant in slowing the pace of deforestation. Table 1 shows some findings from studies since early 2000. The question of how much impact on deforestation Costa Rica gained with its PES investment is still open.

agroforestry in seven Mexican states, with \$4.8 million in 2008 to protect 86,385 ha. The success of the PSHA is such that, between 2003 and 2005, less than 0.1% of the nearly 300,000 ha covered was deforested (OAS 2009).

The PES approach is not without its limitations. A certain amount of capital needs to be invested up front to make PES projects feasible. For example, finances are needed to set-up and maintain a network of permanent forest inventory and monitoring plots to provide information on changes within the forests protected. This should be done also on a larger scale, nationally and regionally. Only through the information gathered from such networks will it be possible to tell what ecological results come from SEM activities. Such a monitoring network needs to be set up in the main forest ecosystems and management regimes in LAC.

FORESTRY CARBON MARKETS AND REDD-PLUS

Carbon markets represent an important source of revenue derived from forests that, in some cases, can compete with alternative land uses such as cattle ranching and agriculture. During the past two decades, forests have had a small share of carbon markets, particularly in the compliance market under the Kyoto Protocol. Only reforestation and afforestation projects were included under the Protocol, leaving avoidance of deforestation of natural forests out of the international negotiations.

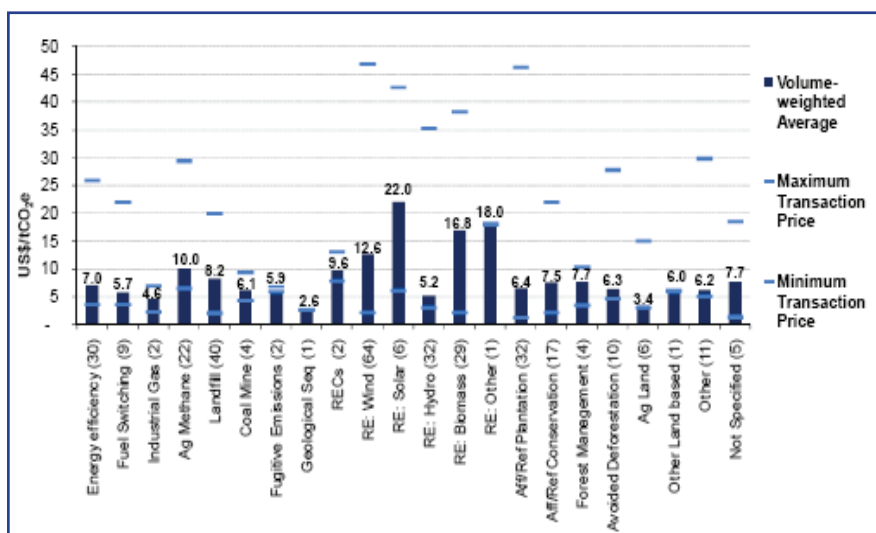
Reforestation and afforestation have presented higher costs than alternative carbon projects, and technologies in the energy and transport sector. New methods to measure carbon stocks in forests are now providing conditions that make investors willing to offset carbon emissions via reforestation and afforestation.

Worldwide funding for forestry for the past decade has been about \$1.1 billion/year, excluding forest protection (Ebeling et al. 2008). The World Bank alone, over the last 20 years, built a portfolio of biodiversity projects worth \$6.5 billion, in substantial part, dedicated to protected areas, but increasingly focused on improving natural resource management and mainstreaming biodiversity (World Bank 2010). That is a significant investment, but it has not met the mounting need of the forestry sector to overcome governance and institutional failures in order to transition effectively to SEM. Carbon markets, if effectively channeled to sustainable forestry, hold the potential to infuse additional resources to this effort.

For example, international compliance carbon markets transacted \$14 billion in 2005, \$33 billion in 2006, \$64 billion in 2007, and \$ 118 billion in 2008 (Ebeling et al. 2008), about doubling each year. However in 2007, only 1% of the credits were allocated to reforestation (Hamilton et al. 2009).

Voluntary carbon markets are also important for reforestation and conservation. In 2007, they transacted \$335 million and, in 2008, \$705 million in carbon credits, representing 6% of world carbon markets (Hamilton et al. 2009). Forestry projects have a 15% share of voluntary carbon markets, well above the 0.5% of forestry projects under the Clean Development Mechanism (UNFCCC 2010). While voluntary carbon markets generate far less revenue than compliance markets in all sectors, investors are looking for projects not only in afforestation and reforestation, but also in deforestation avoidance (Reductions of Emissions from Degradation and Deforestation – REDD), due to the double benefits of protection and social outputs. In 2008, the price/ton of carbon for projects on Forestry Management, Avoided Deforestation, Afforestation/Reforestation Conservation were, on average, similar to other investment categories (Figure 8.8).

Figure 8.8. Credit Price Ranges and Averages by Project Type, 2008, OTC Market



Source: Hamilton et al. (2009).

Note: Numbers in parentheses indicate number of observations.

The volume of credits produced in the LAC region remained steady in 2006-2008, while its share of the world over the counter (OTC) market decreased from 19% in 2006 to 4% in 2008. Lack of government involvement, less efficient systems, and exhaustion of “low-hanging fruit” are the primary hurdles to project development in LAC. Over 56% of the credits in LAC came from Brazil and 21% from Mexico.

REDD+: Reduction in Emissions from Degradation and Deforestation (REDD-plus) may be included in the post-Kyoto regime, increasing options for owners to receive revenue from standing forests. Under REDD+, developed countries would pay developing countries to reduce rates of deforestation via a range of policies and projects. By linking these payments to carbon markets (i.e., putting a value on avoided carbon emissions), investments in developing countries could cut deforestation rates in half by 2030 (Huberman et al. 2008). A 10% reduction in annual deforestation from this scheme would generate over \$600 million annually in LAC, with carbon priced at \$5/t; at \$30/t it would be \$2500 million (Eliasch 2008).

Other estimates of the scale of REDD+ financing vary from \$2 billion to \$33 billion/year (Ebeling et al. 2008; Stern 2008; Eliasch 2008). Actual amounts invested would depend on details of the final agreement. For Ecuador, the potential yearly income is estimated in \$36 million, for Brazil \$208 million, Venezuela \$35 million, and for Bolivia, Peru, and Mexico just under \$20 million each (Huberman et al. 2008).

The LAC region has 17 sub-national REDD+ projects in advanced stages of implementation: in Brazil (7), Ecuador (1), Paraguay (1), Peru (4), Bolivia (1), and Guatemala (3). Together, these projects will protect about 14.8 million ha of tropical forest, avoiding emission of 523 million tons of CO₂ (Cenamo et al. 2009).

For investors, one of the main attractions of REDD+ is the low cost compared to investment in other sectors to reduce emissions, such as the energy industry, and in waste handling and disposal. For providers in developing countries, part of the opportunities are related to high deforestation rates that some LAC countries register, particularly in the Amazon region (see Table 8.10 and Figure 8.9 depicting the potential contribution of Amazon Countries in REDD+ markets; see also Box 8.16.).

Agroforestry on small-scale farms and community forest plantations is also expanding rapidly, with opportunities to promote patterns of agricultural development that enhance ES. The challenge for forestry companies is how to translate these assets into new streams of income

Table 8.7. Deforestation in Amazon Countries: Potential for REDD- Plus Investments

COUNTRY	MPV	IRR
BOLIVIA	-270.000	-0.45
BRAZIL	-2,821.670	-0.55
COLOMBIA	-47.670	-0.10
ECUADOR	198.000	-1.60
GUYANA	(0)	(0.00)
PERU	-94.000	-0.10
SURINAME	(0)	(0.00)
VENEZUELA	-288.000	-0.60
TOTAL	-3,719.340	-0.20

Source: Ebeling et al. 2008 [PLS ASSOCIATE WITH TABLE 1]

at a time when prices for timber, pulpwood, and other products are relatively stable or declining. Forests could provide potential financial benefits from the sale of the above mentioned ES, improved human capital from associated training and education, and strengthened social capital due to investment in local cooperative institutions (Scherr et al. 2008).

Finally, the creation and growth of ES markets is leading to attempts to stimulate private-sector investment in ES and social development. This includes the creation of the Brazilian Environmental and Social Stock Exchange, and the Healthy Planet Stocks to be issued by Mexico's Sierra Gorda Biosphere Reserve.

Figure 8.9. Potential Contribution of Amazon Countries in Global REDD+ Markets

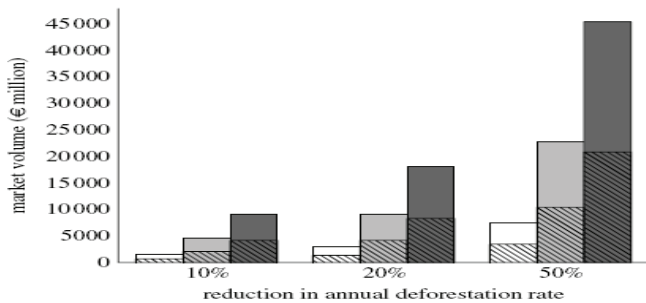


Figure 1. Scenarios for potential global market value of REDD credits at variable carbon prices and reductions in deforestation rates. Bars display global potential market value, and diagonal lines represent the contributions of Amazon countries. Carbon price €/tCO₂: open bars, 5; grey bars, 15 and black bars, 30.

Source: Ebeling et al. (2008).

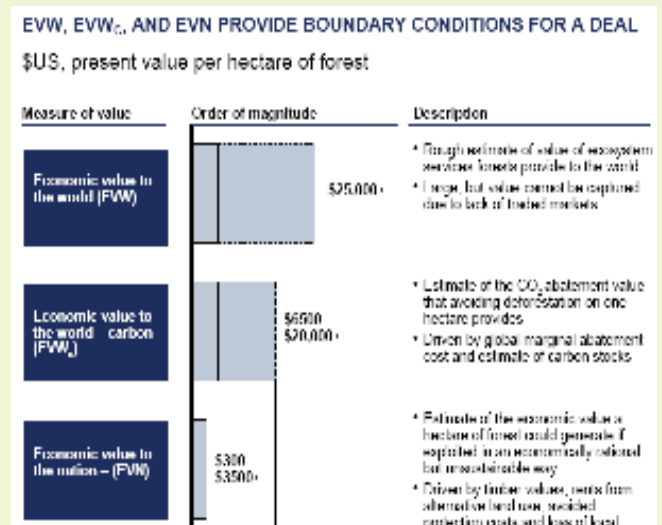
Note: Scenarios for potential global market value of REDD credits at variable carbon prices, and reduction in deforestation rates. Bars display global potential market value, and diagonal lines represent the contributions of Amazon countries. Carbon price EU/tCO₂; open bars, EU 5; grey, EU 15 and black bars, EU 30.

Box 8.15: Analysis of BAU vs. SEM from Standing Forests in Guyana

In Guyana, with a Certified Emission Reduction (CER) price of approximately \$20/t and assuming only credits generated for carbon stored in biomass above ground, CO₂ abatement under REDD+ would range from \$6,500 to \$7,000/ha. Valued at projected global marginal abatement costs of \$60 to \$80/t in 2030, the economic value could eventually exceed \$20,000/ha of forest protected from deforestation. These values vastly exceed most opportunity costs for alternative land use, like agriculture, ranching and timber extraction. The figure in this box shows the values/ha in different markets, and the potential revenue generation for different land uses. The Office of the President of the Republic of Guyana (2008) estimated a national economic value using a baseline scenario in which Guyana pursues economically rational land-use opportunities: extraction of timber (\$1.2 billion) and post-harvest land use such as agriculture and cattle ranching (\$4.9 billion) with a contribution from avoided costs of protection (\$0.3 billion) and a downward adjustment for the loss of local ES (\$0.6 billion).

By forgoing these options, Guyana incurs opportunity costs on the order of \$4.3 billion to \$20.4 billion in present value, in theory, equivalent to an ongoing opportunity cost of \$430 million to \$2.0 billion for forest protection. Using a conservative estimate of avoided emissions (~343 tCO₂/ha), this sum translates into an abatement cost of roughly \$2 to \$11/tCO₂e, which compares favorably with other abatement options available (McKinsey & Company 2008).

Present Values of Different Land Uses of Forests in Guyana



Source: McKinsey & Company (2008).

PART III

CONCLUSIONS AND RECOMMENDATIONS

8.9 CONCLUSIONS

BAU forestry practices in LAC grew out of conditions of relative abundance of forest resources and scarcity of agricultural land. On the agricultural frontiers, where countries were expanding their economies internally, forests were seen as an obstacle to be overcome. The focus was on taming and settling the wildlands to make their resources available to growing populations and to build productive societies. Forest resources were treated as if they were cost-free inputs to the expansion of economic activities. Externalities fell not on the entrepreneurs, but on relatively powerless communities living close to the forests or downstream. In this context, BAU approaches were successful; they fit the times.

Later, as frontiers matured and the seemingly endless forest lands became scarcer, more developed societies no longer accepted externalization of environmental and economic costs associated with predatory deforestation. Timber-based enterprises and their allies in extracting forest resources have felt the pinch. The evolving situation has brought forth the need for forest management, and a move toward sustainability. SEM approaches have begun to emerge as successors to BAU in these changing times. The importance of natural capital and ecosystem services (ES) has come into focus in one place after another. Examination of this new context, as in the preceding pages, leads to a number of conclusions.

1. BIODIVERSITY AND ES ARE ESSENTIAL TO DEVELOPMENT OF SUSTAINABLE FORESTRY VALUE CHAINS.

ES such as soil fertility, moisture, and stabilization; photosynthesis and growth; biodiversity and gene pools; pollination and seed distribution; water cycles, and many other natural processes are essential to the economic production processes based on timber resources and NTFP of many sorts, both in natural forests and plantations. The many benefits to society by ES, mediated by a diversity of forestry value chains, greatly exceed the costs of conserving them. Forest-related industries contribute well over \$50 billion to GDP in the LAC region, counting timber and wood products, NTFP, and processed medicinals (Simula 1999). With proper royalty, fee, and taxation arrangements, forest protection could be put on a self-financing basis. Yet, the price of restoring ecosystems,

once they have been degraded, is high. A key target for policy is to ensure that the costs of maintaining ES should not be externalized by the economic interests that benefit from forests. A range of ES essential for sustained forest productivity has been identified in this chapter. Among the more exotic: in Guyana's Iwokrama forest 51% of 172 timber species are dispersed by mammals and 21% by birds, supporting sustainable forestry there (ITTO/UICN 2009).

2. DECISIONS TO CONVERT FORESTS TO OTHER LAND USES OR TO MINE THE RESOURCE DISCOUNT LONG-RUN COSTS.

The decision to convert forests to other land uses or to mine the resource as if it were not renewable (predatory logging) should be based on the economic benefits and costs involved, both private and social. Traditionally, in BAU scenarios, decisions to convert forest lands are based on a private cost, short-term perspective. This BAU preference is reflected in estimates that deforestation worldwide has meant a financial loss of \$1.8 trillion to \$4.2 trillion (Eliasch 2008).

Rarely are negative externalities on a local scale incorporated into private cost decisions; even less so, on a global scale. The decision to deforest 3.5 ha of mangrove forest to plant maize in Barra de Tecoanapa, Mexico allowed farmers to harvest 2,515 kg of grain and realize \$88 in net revenues in the two years before the field's fertility collapsed; but, externalities in that period were 32 times higher, including losses of \$2,805 in reduced fisheries catch and lost production of honey, wood, fuel, small game, and other NTFP. After five years, the losses totaled \$21,741, adjusted for inflation (Hernández et al. 2000).

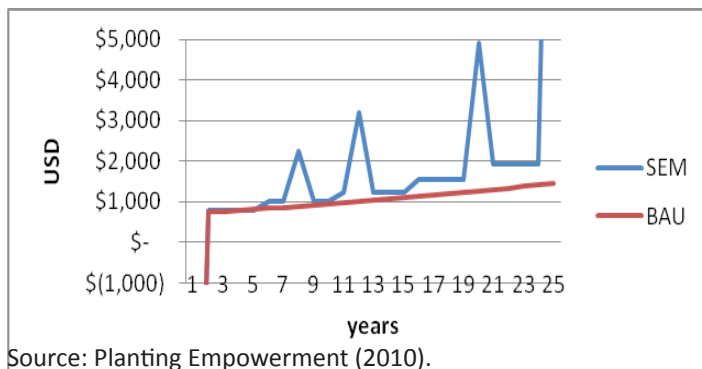
This kind of decision making is primarily due to weak governance — lack of policies that foster incorporation of such externalities — and also to lack of information on the true costs. Where regulatory measures do exist, such as requiring impacts to be offset, they are rarely enforced.

Clearly, the short-term perspective has been a principle driver of BAU forest conversion. This chapter has referred to examples in LAC that show how long-term economic, social, and environmental benefits, formerly sacrificed, can be achieved by sustainable forestry management (SEM). Case studies illustrate the potential for governments (e.g., Costa Rican Payments for Environmental Services Program), private investors (Futuro Forestal, Planting Empowerment) and local NGOs (Xate Palm Fronds, Maya Nut Program) to engage in programs that improve overall returns from forest use, including progress on social indicators and conservation of biodiversity and ES.

Planting Empowerment (PE), for example, calculates that lease payments from its SEM reforestation projects, with profit-sharing for

landowners and communities over 25 years, offers an IRR of 11.24% that is significantly higher than the BAU IRR of 6.24%. Figure 8.10 shows the Net Present Value (NPV) estimates by year using an 8% discount rate. The BAU NPV is for an individual landowner who rents or uses the land for cattle or maize. The SEM NPV is based on reforestation with mixed species (Case Study 8.3). BAU continues to be profitable for the individual, yet falls short of the benefits of the SEM approach. If total social costs and benefits were included in the equation, BAU will likely show a downward slope and SEM would give substantially higher benefits.

Figure 8.10. Net Present Value by Year at 8% discount, SEM vs. BAU (Planting Empowerment)



SEM PRACTICES CAN LEAD TO REDUCED SOCIAL AND PRIVATE COSTS, AND HIGHER PROFITABILITY FOR FIRMS.

A variety of examples of SEM practices were found to offer better financial returns for companies than the BAU approach. Besides the SEM reforestation model of Planting Empowerment (discussed earlier), reduced impact logging (RIL) has been shown to be competitive with conventional logging (CL), even without taking into account the enhanced value of future production of the better-protected residual stand. A study in Brazil's Amazon (Box 8.9) found that efficiency and productivity increased for a typical RIL operation, compensating for its higher up-front costs. Damage to the residual stand was much lower, and overall cost/m³ associated with RIL was 12% less than the cost of a comparable CL job (Holmes et al. 2001).

Despite the overall benefits of RIL, the lack of information on the real costs of CL and other BAU practices impedes wider adoption of SEM. Land titling and market signals that reflect scarcity are critical to shift current forestry BAU practices to SEM approaches. Without

regulatory constraints, the opportunity cost of RIL and other SEM practices may be too high to attract forestry companies to change their behavior until forced by resource constraints.

CERTIFICATION OF SUSTAINABLE MANAGEMENT IS ESSENTIAL TO ENGAGE EMERGING MARKET FORCES.

Certification of sustainability, with chain-of-custody sourcing of forest products, is an important tool in crafting a switch to SEM. Certification harnesses market forces to foster formalization of the forestry sector — heretofore, largely informal, inefficient, and unsustainable in LAC countries — on the promise of economic benefits that depend on internalizing basic environmental and social costs. Certification's potential to leverage access to massive markets in the EU and US, where consumer support for certified products is more developed, drives behavior change among entrepreneurs and policy makers alike. The promise of certification lies mostly in better market access; however, in certain niches, certification may also permit access to premium prices for forest products. In Guatemala, FSC-certification permitted community concession enterprises to raise their revenues by 209%, based in part on price premiums for certified mahogany (PROFOR 2010). In Honduras, forestry communities increased their revenues by 128% to \$579,375 with only a 19% increase in volume harvested, after attaining certified markets.

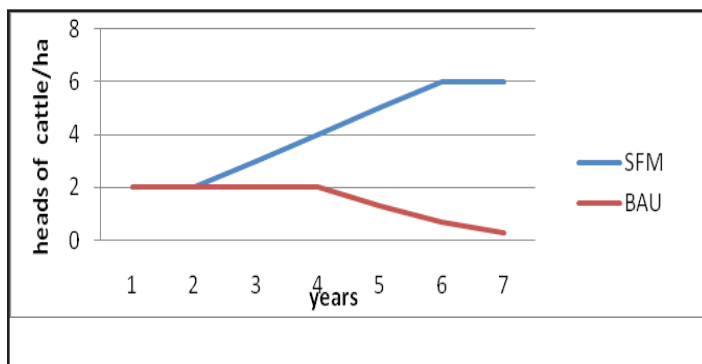
Certified forests are now a very small share of total forested area, around 1.2%. Thus, an important opportunity emerges for companies and communities that exploit forest products to differentiate their products and make them more competitive. Current trends suggest that, in the future, certification will be mandatory in most important markets, thus, losing part of its attractiveness as a differentiator. As more producers get certified, price premiums will lower constantly.

FOREST CONVERSION AND BAU FORESTRY PRACTICES, PARTICULARLY IN THE TROPICS, LEAD TO DIMINISHING RETURNS FOR COMPANIES AND FARMERS.

Within the humid tropics, agriculture, cattle ranching, and forestry plantations following BAU land-conversion practices are, in the long run, only marginally profitable, if at all. This is especially true where accessible, easily-worked bottomlands are deforested first and, then, the more costly clearing of marginal, steeply-sloped areas continues. Sharply declining fertility undermines future agricultural or forest productivity. This ultimately affects not only farmer income but also the livelihoods of forest-dependent people who experience loss of vital NTFP and other resources. Lost soil fertility brings increasing use of fertilizers to compensate, raising production costs, and lowering internal rates of return (Mackensen and Fölster 1999) and finally, polluting ground and surface waters.

Several economic analyses (e.g., Hetch 2008; Almeida and Uhl 1995) show that ranching in the Amazon, due in part to soil nutrient loss after a few years, has very low or even negative productivity if the gains from land speculation are not taken into account. Weeds and soil degradation in Brazil, typically, reduce stocking rates from two head /ha during a pasture's first four years to only 0.3 head /ha a few years later (White et al. 2001). In contrast, Brazilian states that have promoted agroforestry systems on their landscapes have seen productivity raised: as many as three times more cattle per hectare compared to BAU cleared pastures (Brack 2000). Figure 8.11 reflects the SEM and BAU scenario in areas of Brazil on cleared pastures, and the difference in productivity obtained per ha in raising cattle.

Figure 8.11. Head of Cattle per Hectare in Brazil (SEM vs. BAU)



Sources: Projections adapted from White et al. (2001) and Brack (2000).

DIVERSIFIED REVENUE STREAMS HELP CONSOLIDATE SEM, INCLUDING PAYMENTS FOR ES (PES).

Production systems need not be used exclusively; often, options can be created for a range of income flows, particularly for local actors engaged in NTFP, PES, or ecotourism. Companies may focus on timber but license other actors to harvest NTFP in their concessions or private forests, or benefit simultaneously from carbon markets, as does the Futuro Forestal business model in Panama where IRRs average 11%. Timber companies often benefit from income diversification, including revenue streams from carbon sequestration, NTFP, or other ES (Scherr et al. 2004). This will both foster and benefit from an integrated approach to resource use planning and implementation.

In LAC, varied initiatives are underway to value ES and mobilize market-based funding for them. In 2008, at least 22 countries from LAC had engaged in PES projects or in studies to implement one (OAS 2009). PES for watershed services in LAC accounted for \$555 million, conserving 8.9 million ha. In Mexico, PES for Hydrological Services (PSHA) are funded by \$18 million in federal revenues from

water fees (Munoz-Pina et al. 2008). They have also been channeled to implement agroforestry arrangements in seven Mexican states, amounting to \$4.8 million in 2008 to protect 86,385 ha. The success of the PSHA is such that, between 2003 and 2005, less than 0.1% of the nearly 300,000 ha covered was deforested; what was deforested was by fires.

Several countries are designing and testing tools to access carbon markets; good opportunity for forest conservation, social development, and revenue generation appears to lie in carbon sequestration schemes like REDD+. Projected revenues for forest land from these markets will be attractive, if a post-Kyoto regime (taking effect after 2012) includes avoidance of deforestation and forest degradation as a service that can be paid. In Guyana, with a Certified Emission Reduction (CER) price of approximately \$20/t and assuming only credits generated for the carbon stored in biomass above ground, carbon abatement under REDD+ would range from \$6,500 to \$7,000/ha (McKinsey & Company 2008). For LAC governments, avoided deforestation may be a tool for rural development, poverty alleviation, and conservation, simultaneously. Some carbon projects and REDD+ initiatives have been piloted; based on these pilots, facilitating conditions need to be put in place: strengthened rural institutions, generation of reliable information for investors (i.e., carbon stocks, additionality, permanence, and monitoring and evaluation), and legal frameworks.

SEM CAN SERVE AS A FRAMEWORK TO PROMOTE EQUITY.

SEM approaches can provide options for forest-based and rural communities, from timber and wood products to NTFP, PES, and ecotourism, among others. The earnings from such revenue streams are of particular importance to less advantaged populations, but the stakeholder involvement, empowerment, and skills building associated with SEM project planning and implementation can be equally important.

Roughly a quarter of the world's poor and 90% of the poorest strata depend substantially on forests for their livelihoods (World Bank 2001). About 80 % of the population in the developing world use NTFP for health, nutritional, and household needs. At least 150 NTFP are traded internationally (Etherington 2008). These patterns are reflected in LAC too. In the Amazon basin alone, formal trade in NTFPs is valued at \$200 million/year (CATIE 2008). In Brazil, Bolivia, and Peru the brazil nut production chain provides jobs to 15,000 people (FAO 2009). In Bolivia, brazil nuts constitute 45% of forest-related exports, at \$70 million/year (CIFOR 2008a). Forest-dependent people, together with small- and medium- forestry enterprises, have the potential to participate in SEM, provided they have access to start-up resources, technical assistance, and market information. Initiatives such as the Maya Nut Program show that by recovering traditional knowledge of native species use and exploring new markets, local NGOs can conserve threatened ES while improving income and food security for rural communities.

In Guatemala, Rainforest Alliance supported villagers of Uuxactún to establish sustainability standards and certify sustainable forest harvesting of xate palms; 30 million fronds are delivered worldwide each year for home and church decorations (especially Palm Sunday). The shipments earn more than \$100,000/year for the community, with over half going directly to the 1,300 collectors. According to Floridalma Ax, a member of the Conservation and Management Organization of the community's forest concession in the Maya Biosphere Reserve, women, who until recently had no cash income, now earn \$6 to \$7/day harvesting, selecting, and packaging the xate for export. In the Selva Maya, where 50% of the population has no formal education, wild xate harvesting generates about 10,000 jobs, especially for women.

Similar equity promotion through benefits to impoverished rural populations is documented for Costa Rica, where smallholders who protect forest or reforest critical watersheds are paid \$30 to \$50/ha/year in PES — thus, lifting out of poverty 50% of those who had been below the poverty line (Scherr et al. 2004). In Mexico, where in 2004 similar kinds of PES were being made in similar amounts, 83% of the payments went to marginalized population centers (Ruiz-Perez et al. 2005).

INFORMATION AND AWARENESS NEED IMPROVEMENT.

Better data on the status of forest resources, monitoring and evaluation of SEM, and public information programs should be components of SEM programs at each level: enterprise, community, local government, and national programs need to engage broader understanding and public support. Policy makers, advocates, and investors: all require information to make sound decisions.

These conclusions are consistent with the graphical analysis of the standard BAU/SEM paradigm in Chapter 2 (Figure 2.4). Net gains from BAU forestry — high grading, deforestation, and land-use conversion — decline as accessible, easy to work forests become scarce, thereby raising costs. Growing societal resistance to predatory logging practices and externalization of impacts brings regulation and fees, further raising costs. As the curve for BAU net returns is forced downward, scarcity of forest resources and the development of more sophisticated market opportunities (e.g., certification and PES) raises the returns possible via SEM. Eventually, the evolving trade-off drives a shift from BAU to SEM. Further graphical analysis on the role of market forces, the effects of subsidies, and the introduction of policy instruments is likewise applicable.

THE TRANSITION FROM BAU TO SEM IS FOSTERED BY INTRODUCING POLICY TOOLS INTO DECISION MAKING

Initial investments required for shifting to SEM in most of the forestry practices described in this chapter — like reduced impact logging (RIL), certification, and establishment of mixed native species — often deter forestry managers from adopting them. However, if total

costs and benefits under BAU and SEM are compared at the firm level and forecasted, SEM is often not only affordable but necessary to maintain margin profits. Lack of information of the true costs and benefits, enforcement, forestry planning, and institutional weaknesses in the forestry sector are some of the main bottlenecks in the BAU to SEM transition process. Economic incentives such as tax breaks to companies that invest in SEM approaches and use of government procurement power to establish standards and certification as the norm: these are tools that can facilitate initial uptake.

Policy instruments such as promotion of certification and PES schemes, including carbon markets and fiscal tools to help with initial funding, will pay for themselves in improved fee and tax returns once programs are off the ground. Certifications such as the Climate Community Alliance Standards (CCAS) are important for shifting abandoned areas previously devoted to agriculture or cattle raising under BAU standards to forested areas under a SEM practices, using REDD+ and other carbon storage PES options.

NTFP UNDER UNSUSTAINABLE EXTRACTION RATES CAN CAUSE THE INDUSTRY COLLAPSE.

Rattan was one of the first documented examples of NTFP overharvesting (de Beer et al. 1989); palm heart overharvesting has been shown to underlie the decline in heart of palm production from forest-growing species observed over the last thirty years (CATIE 2008). Unsustainable extraction rates, typically driven by high market demand, have put numerous plants on the brink of extinction. In Ecuador, one of the most well-known medical herbs in the world, *Cascarilla cinchona pubescens*—the original source of the potent anti-malarial drug quinine — may be threatened by overexploitation (WWF 2010). The number of medicinal plants and other NTFP used in LAC is large; in most cases, there is very little information on their status — population numbers, structure, and whether they are threatened, endangered, or extinct. Nevertheless, the disappearance of valuable plant species from even a single region may have important economic impacts on local populations.

FORESTS AND COMMUNITIES ARE VULNERABILITY TO CLIMATE CHANGE.

Climate change, in general, increases the risks under both the BAU and SEM scenarios. The dieback or geographical shifting of forests predicted by some analysts, due to increasing global temperatures and dryer weather globally or regionally, may affect the forestry industry and communities who make a living from forestry resources. Changing forests will also affect other sectors of the economy through their effects on such factors as biodiversity, water provision, pollinators, pests and diseases, recreational and tourism values, and CO₂ emissions. At the same time, forests may be more important than ever for their provision of ES that contribute to the capture of carbon, storm mitigation, and micro climate modulation. Maintenance

of biodiversity and healthy ES will position forests to be adaptable and, thus, more sustainable. Continued degradation under BAU practices threatens that aspect of forests, raising the region's vulnerability to climate change.

8.10 POLICY RECOMMENDATIONS

For success, SEM policies need to be framed to work toward essential goals: reliable information, incentives and markets for forestry production, certification and corresponding procurement, governance and enforcement, diversification of products, formalization of the sector, and improved competitiveness of sustainable forest use.

IMPROVED INFORMATION AND ANALYSIS

Scarcity of reliable information is one of the main factors affecting decisions on SEM in LAC. Knowledge of a general sort is often available, but specific data on the case in point is not. For example, biological information on composition and structure of forests is abundant and, generally, clear ideas on basic forest functioning are available from years of research. Thus, generalizations on nutrient cycling and loss of fertility after deforestation are available, as are overviews of forest reproduction (pollination, seed dispersion, germination, and growth, etc.), nutrient uptake, and many other processes. But the details that control productivity at each site are highly specific to that place, its history, and the management interventions contemplated. Site-specific data to support planning, or the monitoring and evaluation of results are seldom on hand.

Socio-economic information is also needed, and often deficient at specific times and places. For instance, land tenure issues and a lack of definition of property rights remains a barrier to organization of forest enterprises in many places. Property rights are necessary for ES markets derived from forests to develop; yet, property rights are poorly developed in most producer countries. Governance processes are typically weak, including knowledge by users of relevant law and regulatory measures, as well as permitting and reporting processes themselves. Consultation of stakeholders and social auditing of forestry agencies at the local level by stakeholders has been very useful in some countries (e.g., Nicaragua) but is not widely practiced.

Economic effects are often not understood. The external costs of BAU are apparent but perception is limited primarily to academic circles and specialized forestry organizations. Despite the fact that these sources have been reporting for decades on the impacts of BAU, this information has often not yet been internalized in daily

business decisions nor taken into account in local or country-level public policy.

A review of existing information and development of standard biophysical and socioeconomic methodologies to obtain the most essential data for decision making could be an important step toward more efficient functioning of Forestry Departments and forestry support organizations in the region. This information would also be useful for decisions affecting forest resources in multi-sectoral areas like rural planning, infrastructure development, mining, agriculture, and tourism development, among others.

Information should be generated on those aspects of economic processes that are likely to be challenged by change and are relevant to the management of forest resources and ES. For example, planning activities at a regional scale may include identification of areas with great or unique biodiversity or specific productive potential, where SEM can contribute to the capacity to adapt to climate change.

Mechanisms to encourage forest enterprises to maintain transparent registers on costs and benefits of their activities are also needed. This will help Forestry Departments understand the economic and environmental trade-offs of different management regimes.

Private and community initiatives will seldom attract potential investors for carbon and REDD+, among other ES markets, if there is no reliable, transparent information on ES provision. One way to provide such data is to establish permanent plots and registers that can give comparative data over time on natural and managed systems. Forest users can provide data on their costs and benefits, while local authorities or monitoring boards can provide data on the flow of forest ES. The use of satellite imagery, GIS, modeling of biodiversity and ES, and modeling of the dynamics and tradeoffs among different land uses are tools being adopted in LAC. These tools and data sets will help frame policy decisions that balance economic, social, and environmental interests.

INCENTIVES AND MARKETS FOR FORESTRY PRODUCTION

Biodiversity and ES are too often lost in regions not only for lack of information but for lack of incentives or the existence of perverse incentives. The use of incentives (i.e., subsidies, soft credit, fiscal credits) has been important for forestry industry development in LAC and, undoubtedly, has driven the rapid expansion of plantations in some countries. But, these incentive instruments may also distort markets and have unanticipated effects.

Some subsidies undermine SEM, as by inducing disproportionate conversion of forested land to favor, for example, biofuel production, timber extraction, or cattle ranching. In countries like Chile, subsidies have promoted rapid appropriation of land by large companies. In Costa Rica

and Nicaragua, subsidy programs have been alleged to drive inequity, economic inefficiency, and environmental damage. By facilitating activities that would not otherwise be profitable, such subsidies lead to inefficient allocation of resources from a social perspective, as when they induce land conversion that results in ecosystem degradation.

In cases where social benefit is clearly high but costs to private actors are also high, as in establishment of a biodiversity reserve or a conservation easement involving private lands, incentives to compensate for the cost of lost opportunities may be a useful policy tool to support SEM.

A market price structure for hidden benefits of forest ES may serve to avoid negative externalities and incentivize forest management. One way to achieve this structure for hidden benefits is through legal and regulatory provisions that promote compensation mechanisms to land holders who voluntarily carry out sustainable practices. Legal provisions in the water, biodiversity, protected areas, and forest laws of many countries — Colombia, Paraguay, Peru, Ecuador, Bolivia, Panama, and Costa Rica, among others — foster use of economic incentives to compensate providers of ES. PES initiatives are, thus, one of the options in shifting perverse subsidies toward an SEM approach. PES schemes also take place through private deals. In either case, governments need to provide an appropriate regulatory environment to facilitate widespread adoption of this type of incentive, as has been done in Mexico and Costa Rica, for instance. Another proven tool is tax relief or tax property exemption for those who protect ecosystems.

Other market-based instruments include environmental offsets, regulated in several countries, to facilitate creation of markets around offsets — such as habitat or conservation banking — that help restore or protect critical forest habitats. However, these markets are not likely to contribute substantially to equity and poverty alleviation, unless proactive efforts are made to recognize rights and shape markets to provide equal access to low-income producers of forest ES.

DIVERSIFICATION OF PRODUCTS

Promoting diversification of revenue flows is only prudent. Under SEM, it is often the combination of benefits to various groups that makes a particular land use superior to a BAU approach. Combining primary and secondary production, PES and ecotourism, buffer zones and corridors, with responsible management and conservation of both natural forests and tree plantations, sustainable agriculture and labor-absorbing processing facilities will be essential — both to “grow” the economic benefits of SEM and to build more resilient communities and enterprises that can respond to market variability and adapt to climate change.

CERTIFICATION AND PROCUREMENT NORMS

Third-party certification of sustainable timber and NTFP production is a strategy that helps forestry companies shift to

SEM. Certification assures that production practices are carried out sustainably, according to a specific set of criteria that balance ecological, economic, and social considerations. Standardization of products and of quality criteria is an important element. The first step, in order to extend adoption of certification standards is creation of capacity at the forest management unit level. Training programs that build skills, and prepare landowners and enterprises for certification will facilitate expansion of areas in which production is certified; currently, certification activity is low in LAC, compared to other regions. Reducing direct and indirect costs of certification for smallholders or cooperatives will also facilitate adoption of certification. This can be part of a national competitiveness strategy, often targeting international markets.

On the other hand, most of the markets for timber and NTFP are domestic. There is a clear opportunity for public sector procurement policy to support the transformation of natural resource sectors and other sectors that absorb the potentially certified products. Governments are among the largest consumers in an economy; their procurement norms and activities can encourage wider adoption of sustainable practices. This action can include setting norms that require use of sustainably produced products with public funds, favoring certification processes, and raising awareness of the social and environmental consequences of consumption decisions. Similar procurement policies can be extended via regulatory measures extending norms, standards, and fiscal policies to a broader segment of the economy.

FORMALIZATION AND GOVERNANCE

Formalization of the forestry sector is a significant step toward improving both governance and competitiveness. Formalization may be posed more broadly, covering renewable natural resources, in general. While formalization will help reduce deforestation and ecosystem degradation, it should be focused on realizing the long-term economic and social opportunities that the sector presents. Government has a central role in promoting the institutional frameworks in which SEM is possible, taking into consideration the characteristics and needs of the sector: stakeholder involvement, logistics in remote areas, insurance, labor legislation, administrative procedures, and transparent conflict resolution mechanisms, among others. Local governance structures have been widely established, often at the municipal level, and can be key to adaptation of policy to local needs, effective law enforcement, and hands-on management of forest resources.

Illegal logging and overharvesting of NTFP is in part a consequence of poor governance and enforcement structures; poor governance and weak enforcement structures are an obstacle to SEM and to the realization of its economic and social benefits. While better information, improved legislation, and growing markets may increase the profitability of forest management, without competent governance,

these conditions may also improve returns from illegal logging, overharvesting, and corruption. The consolidation of the forestry sector, thus, must go hand-in-hand with the emergence of national policies and links to the local implementation of those policies, together with more transparent and capable local governance structures. Strengthening of local administrative capacities and, monitoring and control measures throughout the value chain will be crucial.

Local, regional, and national stakeholders should be engaged in the design and implementation of SEM policy and of mechanisms for dialogue and conflict resolution. Control may be carried out by independent agencies in collaboration with law enforcement agencies, but, above all, should be done with local participation in monitoring activities and the elaboration of and use of locally adapted regulations.

IMPROVED COMPETITIVENESS OF SUSTAINABLE FOREST USE

Creation of enabling conditions for competitiveness by strengthening the technical and business capacities for small- and mid-scale

producers can greatly contribute to the selection of sustainable land-use options by producers, and will help reduce management and enforcement costs.

Together, with greater business and technical skills, local actors will also need initial credit resources (or subsidies) and specialized loan structures to be able to invest in SEM and overcome financial bottlenecks, particularly for small producers. For example, forest use rights may not be recognized as adequate guarantees for long-term credit applications. Promotion of microcredit and special funds to support forestry development, such as the BioTrade Fund in Colombia that includes NTFP financing, may support producers with direct loans, capital investment, or by developing mechanisms to make them acceptable risks for banks. These mechanisms will need to support use of appropriate technology and to cover start-up costs.

Lastly, the value chains of the sector must be financially viable and inclusive of local actors, to help reduce deforestation and poverty. Overall, political, legal and institutional frameworks should foster the value chain development needed in order to be able to make SEM economically competitive, and thereby, contributing to equity, and conservation of biodiversity and forest ES.

CHAPTER 9.

TOURISM

Andy Drumm³⁰

9.1 INTRODUCTION

Terms of scale and continued growth, as well as influence on the development patterns of countries and regions, tourism is one of the world's most important economic activities. Though much associated with natural features and environments, international tourism has also been linked to the degradation of these features and locations. This chapter explores the degree to which biodiversity and natural ecosystems underlie the economic contribution of international tourism to development in Latin America and the Caribbean (LAC); this exploration also addresses the extent to which biodiversity and natural ecosystems should be taken into consideration and protected as the basis for on-going economic benefit.

Using case studies from across the region, the chapter compares the implications of two contrasting sectoral development models on the potential for sustained growth and for the sustainability of the ecosystem services (ES) on which the LAC tourism sector depends: the Business As Usual (BAU) model and an emerging Sustainable Ecosystem Management (SEM) model. The chapter will assess costs and benefits under each of these tourism models to make clear an economic roadmap that may facilitate the transition from the former to the latter. The chapter will also note where benefits and costs are distributed in economies and make policy recommendations to enhance efficiency, equity, and sustainability in the LAC tourism sector.

KEY FINDINGS

- The tourism sector, including both the conventional, recreational sun and sand category and the burgeoning nature-focused category, depend on healthy biodiversity and the maintenance of ES. This is manifested by the use of clean beaches, healthy reefs, whitewater rivers, birdlife, fish, whales, forests, and similar natural features as attractions that drive demand.
- Current growth of both recreational and nature-focused tourism and their long term potential in LAC is undermined by a lack of understanding of the contributions of biodiversity and ES to the sector.
- Unsustainable operations that result in degradation of both the surrounding ecosystems and social systems compromise long-term economic returns to the tourism sector.
- The biggest growth segment in tourism is the *nature-focused* category, in which tourists spend more than conventional *recreational* tourists. The spending of nature-focused tourists has a greater multiplier effect in local economies than the spending associated with recreational tourism under BAU. Growth of this nature-based segment is threatened by BAU practices.
- The SEM approach to tourism is now highly in demand in key European and North American markets. Growth in SEM tourism is widely predicted to continue to outstrip that of

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BAU for the foreseeable future. This demand will provide significant business development opportunities throughout the LAC region.

- As natural capital continues to be eroded by BAU tourism, segments of key markets, investors and the media are increasingly seeking alternative SEM tourism opportunities.
- There is a notable absence of data on the value of SEM tourism and the (often hidden) costs of BAU, or more broadly, on the comparative costs and benefits of these two models. If information were readily available, these findings would likely further catalyze a transition from BAU to SEM tourism.
- Certification of tour operations has played a small role, but demand is growing and is likely to become increasingly important in signaling SEM status to visitors planning their trips.
- Niche markets that depend on biodiversity health, such as whale, bird, and reef fish watching, are large and growing rapidly with higher per person spending and increased local economic gains than BAU tourism. However, these SEM markets are extremely vulnerable to deterioration of ES.

PART 1: ECOSYSTEM SERVICES AND TOURISM

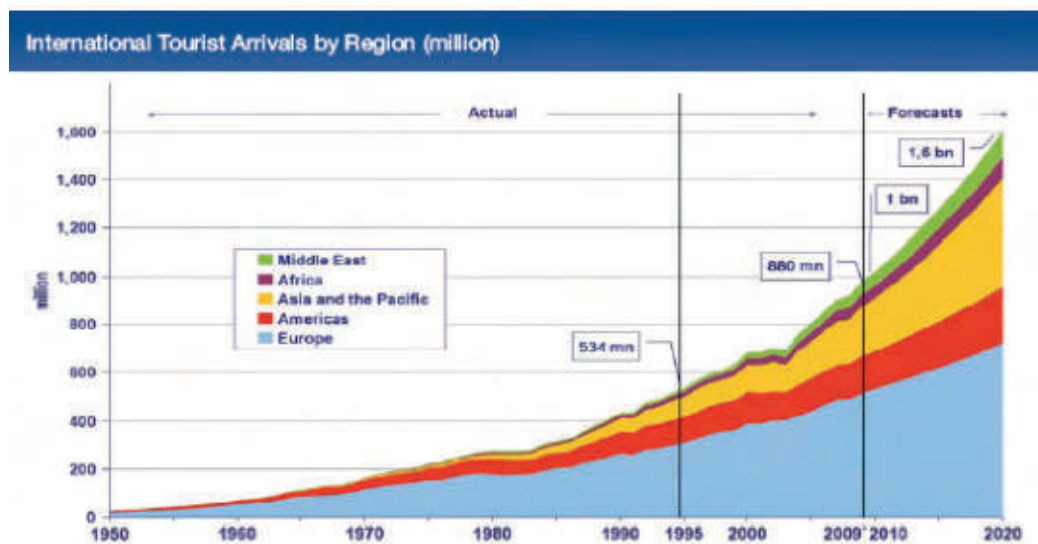


9.2 ROLE OF THE TOURISM SECTOR IN NATIONAL ECONOMIES

Tourism is one of the world's most important economic activities. In 2007, tourism was the fourth largest export market of goods and services globally, accounting for \$856 billion in export earnings. If international passenger transport — transport contracted from companies outside travelers' countries of residence — is included, then international tourism receipts were over \$1 trillion in 2009, or, put more simply, almost \$3 billion was earned by international tourism each day (UNWTO 2010).

The size and scope of the modern tourism sector summarized in this chapter is primarily a result of business as usual (BAU) processes that have successfully built on opportunities to create and exploit travel markets. These BAU endeavors continue to be the backbone of the sector. To a growing extent, however, the size and success of the BAU tourism industry appears to have created conditions that limit future growth, in

Figure 9.1. International Tourism Arrivals



particular by eroding a range of natural and cultural conditions that sustain BAU tourism, undermining sustainability of the enterprise. Increasing overuse or misuse of resources and the weakening of the ES on which tourism depends — together with new and rapidly expanding markets for responsible tourism — have fostered development of more sustainable approaches that are steadily replacing the older models. Figure 9.1 below shows how the actual value of international tourism has grown since 1950 and how the United Nations World Tourism Organization (UNWTO) forecasts this sector will grow through 2020.

The Americas accounted for 20% of the total tourism market, earning \$171 billion in 2007 from international tourism receipts, which equated to an average spending of \$1,200 per arrival (UNWTO 2008). In 2009, the global market share within LAC was as follows (UNWTO 2010): Caribbean, 2.2%; South America, 2.3%; and Central America, 0.9%. Though the LAC region has only a small share of the global market, tourism within the region makes a substantial contribution to economic development and equity in LAC countries, though with potential to go further.

Between 1990 and 2010, average annual growth within the sector globally was 2.9%, while in Central America (6.5%) and South America (3.3%) the tourism sector grew significantly faster. In the Caribbean however, growth was a much lower 1.5% (UNWTO 2010). Mexico ranked 10th among top international destinations in 2007 (UNWTO 2008). The contribution of tourism to GDP for the LAC sub regions ranges from about 2% in South America to almost 20% in the Caribbean

Table 9.1 shows past real and future projected visitor numbers in the Americas, market share between the sub regions, and the growth rates in visitor numbers. Central and South America and the Caribbean continue to grow faster than North America, which has almost 70% of the Americas market.

Table 9.1: International Tourism Arrivals, Market Shares, and Growth Rates in the Americas

REGION	2000	MILLIONS OF VISITORS 2010	2020	% MARKET SHARE 2010	% AVERAGE GROWTH RATE 2010
NORTH AMERICA	92.7	131.9	192.0	69.3	3.6
CARIBBEAN	17.5	26.6	40.0	14.0	4.3
CENTRAL AMERICA	3.2	5.0	7.5	2.6	4.5
SOUTH AMERICA	16.9	26.9	42.8	14.1	4.8
TOTAL	130.2	190.4	282.3	100	3.9

Source: OMT 1997.

The main focus of this chapter is on international tourism, where most widespread and significant impacts are generated, especially in terms of export earnings. In the larger LAC economies, domestic tourism is also significant and growing. Brazil, Argentina, Chile, and Colombia have notable domestic markets that outweigh international tourist demand. Table 9.2 below illustrates this condition with data for Brazil. While the total number of foreign visitors to Brazil has not changed, the composition has shifted to fewer business travelers and more long-haul tourists.

Table 9.2: Number of Visitors in Brazil

VISITORS IN BRAZIL	1999	2009	AVERAGE ANNUAL GROWTH
FOREIGN	5.1 million	5.1 million	0%
DOMESTIC	25 million	54 million	8%

Source: Janér 2010.

TOURISM AND EQUITY

In terms of equity — how the benefits and costs of this growing activity are distributed — the tourism sector has been traditionally weak. The sector has been dominated by a relatively small number of European and North American hotel chains, cruise lines, travel agencies, and airlines that are able to control prices and volumes of visitors to particular destinations. This industry structure has fostered a high volume, low margin business model that relies on economies of scale and low operational costs to maximize profits. That model, characterized by high leakage and low income-multipliers, prevails in much of the Caribbean (e.g., the Dominican Republic, the Bahamas, and Jamaica). For example, in the Dominican

Republic, salaries in the tourism sector are reported as being 16% below the national average. In 2003, 80% of hotel beds were in foreign-owned hotel chains.

In terms of gender equity, in most Caribbean countries far more men are employed in the sector than women (Table 9.3), though in three countries, the trend is reversed. Women also tend to earn less than men in the sector. A Dominican Republic study showed that women earned 32% less than men (PNUD 2005).

Table 9.3. Percentage of Workforce Employed in Tourism Sector

COUNTRY	MEN	WOMEN	Year
DOMINICAN REPUBLIC	10.3	0.6	2007
TRINIDAD & TOBAGO	12.9	25.7	2005
THE BAHAMAS	13.6	16.3	2005
ST. LUCIA	13.7	0.6	2004
ST. KITTS & NEVIS	15.7	24.3	2001
DOMINICA	15.8	0.5	2001
JAMAICA	16.3	0.8	2005
ANTIGUA & BARBUDA	16.5	0.7	2001
BARBADOS	18.4	1.3	2004

Source: ILO 2008.

In South America, dependence on tourism is much less pronounced, though nature-based tourism here is still an important source of employment. For example, one of Venezuela's most popular parks over the last few years is Parque Nacional Morrocoy with an average of 1.5 million visitors yearly. The park generates 5,000 permanent jobs in the areas adjacent to the park, accounting for about 50% of local employment. In Venezuela, the most visited protected areas generate between 30% and 50% of local jobs (Convention on Biodiversity 2008).

Other countries like the Dominican Republic, Costa Rica, and Ecuador have not developed the high volume tourism model. In these countries, a more home grown, nature-focused tourism model has emerged that builds on comparative advantages they possess in terms of biodiversity and unique natural environments. This model emphasizes product differentiation. Human resources cease to be simply a cost factor and become a key to business success through accentuation of cultural manifestations.



9.3 ROLE OF BIODIVERSITY AND ECOSYSTEM SERVICES FOR THE SECTOR

Nature-based tourism. Clearly, the tourism sector is a significant, dynamic component of national economies in LAC; in the Caribbean, countries are heavily dependent on this sector. Tourism attractions that drive the industry can be broadly divided between natural and cultural (including built attractions). Consider that the historic buildings, museums, and bustling markets of France, Britain, and other leading destinations motivate a large portion of global tourism demand. Cultural tourism is also important in LAC, especially on the mainland with its Aztec, Mayan, and Incan archeological sites and Spanish colonial heritage. But, increasingly, the region's natural attractions play the lead. In 1997, the UN World Tourism Organization (UNWTO) estimated that nature-related tourism activities accounted for 20% of all international travel (ILMB of Canada 2001). More recently, the UNWTO estimated this market area to have an annual growth rate of 5% worldwide, representing 6% of the world gross domestic product and 11% of all consumer spending (World Tourism Organisation 2002).

Table 9.4 presents a typology of tourism to help facilitate understanding of the terms used in this chapter. *Nature-based* tourism is divided into a recreational category where nature is passively consumed and a rapidly growing nature-focused category. In the latter category, specific natural components such as wildlife viewing are actively sought while experiencing the attraction, whereas in the former category, built infrastructure

Table 9.4. Types of Nature-based Tourism Activities (Illustrative)

A. RECREATIONAL (PASSIVE APPRECIATION OF NATURE)	B. NATURE-FOCUSED (ACTIVE APPRECIATION OF NATURE)		
	ADVENTURE TOURISM	ECOTOURISM	OTHERS
BEACHES/BATHING	Mountain climbing	Wildlife viewing	Agrotourism
BOATING/SKIING	Trekking	Birdwatching	Indigenous community tourism
CRUISE SHIPS	White water rafting	Whale watching	Voluntourism
VACATION HOMES	Kayaking	Turtle watching	
SPORT FISHING	Surfing	Photo safaris	
VIEWING LANDSCAPES	Mountain biking	Snorkeling (e.g., coral reefs)	
PICNICKING	Scuba diving		
Walking	Snowboarding/skiing		
Horseback Riding	Canopy zip-lining		
CYCLING			

is a major focus (swimming pools, cruise ships, etc.). Both categories, however, require a healthy natural environment and provision of ES.

All nature-based tourist activity depends on access to and maintenance of ES. Four leading examples of ES are sketched here: biodiversity, fresh water, coastal protection, and seafood. Many other ES could have been highlighted, as suggested by Figure 9.2; some will be discussed below.

ECOSYSTEM SERVICES: BIODIVERSITY

Data from LAC show a very strong correlation between tourism demand and the ES of biodiversity. Between two thirds and three quarters of all international tourists visit at least one protected natural area (e.g., Peru (73%) (PromPeru 2008), Argentina (60%), and Costa Rica (65-75%) (Instituto Costarricense de Turismo 1996)). Of Caribbean tourism and hospitality firms surveyed, 94% recognize that they rely on the environment for their livelihoods (Vere Slinger 2002). Many biodiversity-rich countries of the South receive large numbers of tourists: 23 of these countries saw tourist numbers grow over 100% in the last decade, including nine in LAC (Table 9.5). In the LAC region, Argentina, Brazil, the Dominican Republic, and Mexico each receive over 2 million foreign visitors per year (Christ et al. 2003).

The Caribbean has high levels of visitation, with tourists motivated by the natural amenities of coastal environments, particularly sandy beaches with bathing opportunities, palm trees, and coral reefs, for recreational activities like sunbathing, swimming, snorkeling, diving, and skiing. In contrast to this pattern for the Caribbean, tourists in

much of Central and South American seek access to rainforests, cloud forests, volcanoes, national parks, and dramatic natural landscapes for activities like birdwatching, wildlife viewing, interpreted hikes, climbing, and many other nature-based opportunities. Even in destinations where culture is a strong driver, such as Peru's Macchu Picchu, visitors also seek out and appreciate nature and biodiversity.

Natural capital, including high levels of biodiversity, constitutes a comparative advantage that the region has successfully exploited. Yet, the contribution of biodiversity and ES to successful development is under-appreciated, in many cases. For example, consider the case of pricing these tourism experiences. Studies by Rodriguez et al (2008) in Ecuador and Leon et al. (2009) in Peru quantify the economic contribution of nature tourism to development. This work also shows that tourism to natural protected areas earns over 95% of all self-generated revenue for the park systems of these countries, with park visitors prepared to pay significantly more in entry fees. Significant funds potentially generated by biodiversity were, therefore, lost to both countries due to sub optimal pricing.

ECOSYSTEM SERVICES: FRESH WATER

While biodiversity is a key attraction for many LAC tourist destinations, other ES like fresh water provision are basic to their very existence. No recreational or nature-focused tourism destinations function without a consistent water supply — even in arid areas where obtaining fresh water is a challenge for local populations. In the coastal deserts of Baja California, Yucatan, Peru, Northern

Table 9.5. Examples of Biodiversity Hotspot Countries Exhibiting Tourism Growth Above 100%

BIODIVERSITY HOTSPOT/ COUNTRY	INTERNATIONAL ARRIVALS (IN THOUSANDS) 1990		GROWTH 1990-2000 (IN THOUSANDS) 2000	% GROWTH 1990- 2000
CARIBBEAN				
Cuba	327	1,700	1,373	420
Turks and Caicos Islands	49	156	107	218
Dominican Republic	1,305	2,977	1,672	128
BRAZILIAN CERRADO/ATLANTIC FOREST				
Brazil	1,091	5,313	4,222	387
MESOAMERICA				
Nicaragua	106	486	380	358
El Salvador	194	795	601	310
Costa Rica	435	1,106	671	154
Panama	214	479	265	124
TROPICAL ANDES				
Peru	317	1,027	710	224

Chile, the Galapagos Islands, and much of the Caribbean, fresh-water consumption by the tourism industry puts considerable stress on natural ecosystems. Water consumption per capita by tourists is often more than ten times that of local residents. Ecosystems in these areas are being significantly altered by both consumption and the effluents of hotels and resorts.

ECOSYSTEM SERVICES: COASTAL PROTECTION

Another ecosystem service under threat is that of coastal protection by coral reefs and mangrove forests. These coastal protection services are critical to the well being of coastal tourism developments yet tourism itself has been a principal threat to maintenance of these services. Insurance companies now charge higher premiums to coastal resorts where these services have been eroded because of the higher risk the resorts face from hurricanes (IPCC 1995). Coastal communities find themselves more exposed.

ECOSYSTEM SERVICES: SEAFOOD PROVISION

Another important ecosystem service for tourism in coastal areas is the provision of seafood. Healthy coral reefs and mangroves are essential habitat for many commercially-important food species including lobster, crab, shellfish, and fish. Habitat destruction and overfishing — both often related to tourism — is leading to depletion of stocks. Some destinations now have to import seafood from other countries to maintain

the established image of a seaside paradise. For example, studies show that seafood availability declined notably in one area of Costa Rica (Alpizar and Villalta 2008) and in Roatan, Honduras.

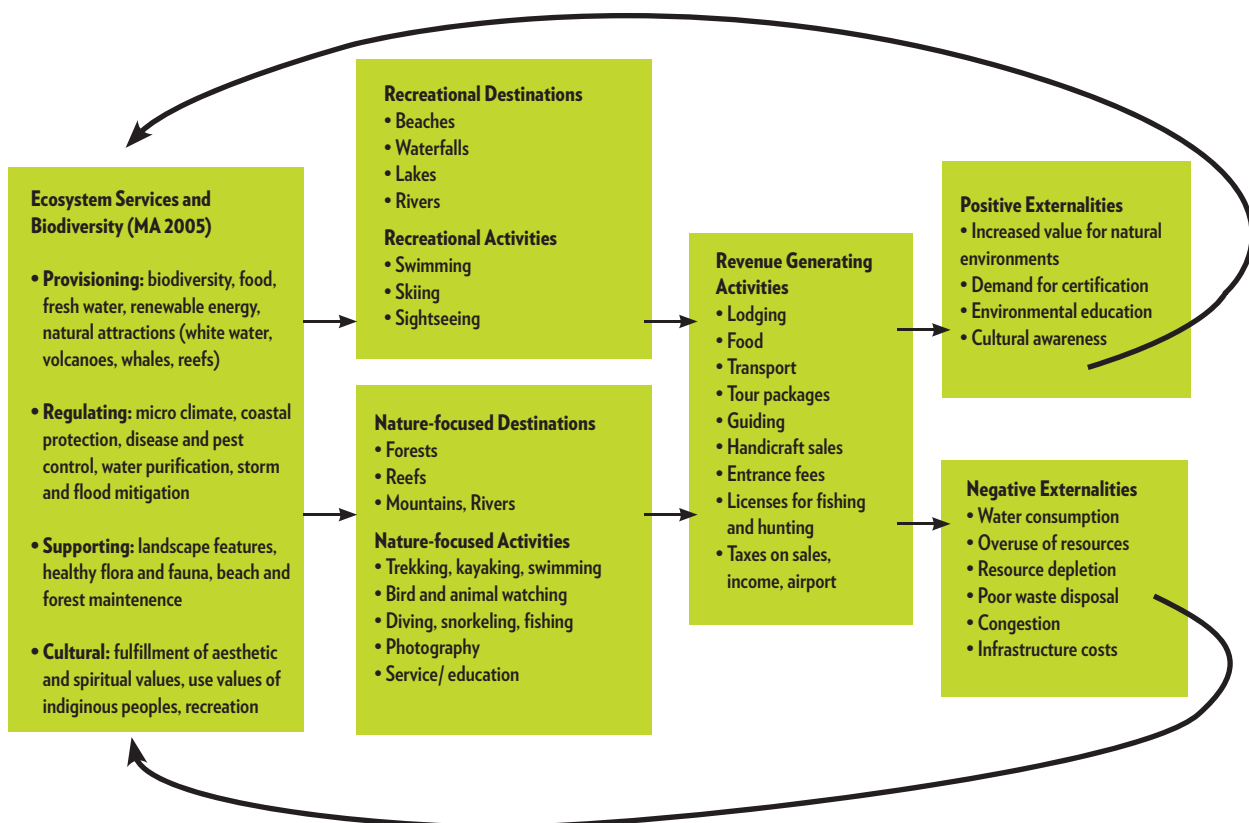
Figure 9.2 illustrates the relations between ES and biodiversity (BD) on the left and both tourism destinations and activities in the second column—differentiating between recreational and nature-focused tourism destinations and activities. Types of revenue generation and impacts or externalities, both positive and negative, are to the right, linked back to the ES via feedback loops.”

PART II: ECONOMIC ANALYSIS

9.4 DEFINING BAU AND SEM

Business as usual (BAU) tourism is the form reflected in most current tourism development, be the type of tourism situated internationally or locally, culturally or in nature. In general, BAU practices are oriented to maximize short-term gain with little concern for externalized costs, impacts on third parties, nor for the long-term durability of the resource base, ES, and economic production chains.

Figure 9.2. Relationships between Biodiversity and Ecosystem Services, Tourism, and Externalities



In the case of the mass-tourism models in the Caribbean, represented by large hotels and resorts, cruise ships, recreational boating, and vacation home development, BAU is linked to seriously unsustainable aspects. Typically treated as externalized costs, these aspects threaten the success of the BAU model: over-consumption of freshwater, inadequate treatment of wastewater and solid waste, serious negative impacts on coastal ecosystems from overdevelopment and crowding, and massive imports, with consequent high leakage from host economies (for example, see Cancun, Box 9.1). In the case of the nature-focused tourism, which is more common in Latin America, these unsustainable features of BAU are shared, but vulnerability is manifested somewhat differently: for instance, in poorly-controlled visitation that leads to degradation of natural areas, and in opening pristine natural areas without sufficient management capacity to ensure sustainability

Based on a business model that requires sustaining high volumes of visitors with low profit margins, BAU tourism is dominated by a relatively small number of high-profile transnational companies. This situation tends to promote loyalty to brands rather than to particular destinations. Tourists may travel with the same company to different places each year; the company is able to switch investment and promotional efforts from one destination to another with relative ease, according to where margins can be best maximized at a given time. This puts immense pressure on each destination country to lower tariffs and other costs so as to maintain a competitive stance. Environmental protection costs are typically the first to be cut by governments that embark on this tourism development model. For example, Panama has just passed a law that will allow the president to waive the requirement that development projects assess environmental impacts (EcoAmericas 2010). This law will allow activities that are environmentally problematic to flourish unchecked, such as second-home real estate developments that stress environmental services.

The BAU models have had great success in their own terms, promoting extraordinary growth and earnings. However, they have also produced many negative environmental and social externalities that tend to undermine their long-term viability in particular sites or countries. This condition is associated with the presence of weak regulatory frameworks, which facilitate maximizing short-term private sector profitability at public expense, to the detriment of public and private benefits in the long term. The short-term focus is exacerbated by insufficient investment in monitoring and impact management capacity.

Sustainable ecosystem management (SEM), on the other hand, mitigates negative externalities and improves long-term economic prospects in the tourism sector. The SEM approach has evolved in response to the many problems that have emerged from the BAU approach. BAU and SEM represent opposite ends of a continuum that runs from short-term to long-term perspectives. At a given time in a country, tourism development will likely be dominated by BAU

Box 9.1. Cancun, Mexico: An Example of BAU Recreational Tourism Development

Prior to development as a tourist resort in the 1970s, only 12 families lived on the barrier island of Cancun. The entire area that now comprises the state of Quintana Roo was made up of relatively untouched rain forests and pristine beaches, and inhabited by an indigenous Maya population of about 45,000 (Sweeting, Bruner, and Rosenfeld 1999).

This tourism development, planned by the Mexican government, has now over 40,000 hotel rooms. Cancun is a prime example of mass sun and sand recreational tourism. Interventions aimed at developing this tourist center have resulted, as of 2009, in the loss of 20 thousand hectares of mangrove forest (CIDAC 2009), an average consumption of 580 liters of water/tourist/day—twice the daily per capita consumption of local residents, and daily power consumption of 36 KWh/tourist (Conservation International 2004) (Comisión para la Cooperación Ambiental 2008), about six times the best practices standard in the hotel industry. Some 750 tons of solid waste are generated daily, for which a third landfill is to be built in the area.

Tourism development has created a permanent population of 300,000. Environmental and social impacts were given secondary importance in the development plan for Cancun. For instance, no provisions were made to house low-income migrants who now work and live in the area. As a result, a shantytown developed, in which 75% of the sewage is untreated (Sweeting, Bruner, and Rosenfeld 1999). Besides mangroves, inland forests were cut down, swamps and lagoons were filled, and dunes were removed. Many bird, marine, and other animal species vanished.

The costs of all these negative impacts are overwhelmingly born by the Mexican public, in an externalization of BAU tourism's real costs in order to increase private benefits. It is highly questionable whether this BAU model would function as a business without, what is in effect, a subsidy from the surrounding environment and populace.

By 2009, tourism revenue was dramatically down, due to varied factors; hotels have dramatically cut prices to try and compete. Cancun's BAU model may be reaching its limits and entering the stagnation phase of its life cycle.

but display elements of SEM to a greater or lesser degree. Some countries, naturally, are ahead of others in recognizing the short-term nature of BAU benefits and the long-term nature of the associated costs. Some have been quicker to understand the degree to which ES and biodiversity support competitiveness in the tourism sector and to encourage strong SEM-based tourism development.

THE TOURISM INDUSTRY STRUCTURE: INTERNATIONAL CONTROL AND LOCAL INITIATIVES

The industry is composed mainly of numerous small and medium-sized enterprises. Yet significant control rests with a handful of multinational corporations. In Europe, for example, just five companies control over 60% of organized outbound travel (WTTC 2002). Few of these big companies have any long-term investments in particular destinations — even large hotel chain properties are often franchises. Thus their influence on tourism in a particular place may be much greater than their long-term commitment to that destination. If environmental conditions worsen, these players have the option of moving elsewhere. Few tourism companies have integrated biodiversity or ecosystem maintenance considerations into their day-to-day management practices. Most remain unaware of and unaccountable for potential (and actual) impacts of their activities (Christ et al. 2004). These patterns reflect conventional, BAU practices on a worldwide scale, with externalization of costs and impacts, so as to focus on short-term gain.

However, some major travel companies recognize the importance of managing their businesses to minimize negative impacts and to find ways to help promote conservation and sustainable development.³¹ These companies realize that by helping to maintain the cultural and biological integrity of the places their tourists visit, they can both enhance the quality of the product they are selling and improve their business reputation, thus improving prospective long-term earnings.

A significant development in the last few years is the establishment of voluntary environmental initiatives by hotel chains, tour operators, and ground handlers, including green certification systems (see Section II.4), conservation awards, and eco-labels. Many such initiatives are supported by NGOs and governments; but all voluntary performance standard-setting depends on private sector commitment and consumer awareness. NGOs such as the International Ecotourism Society, Tourism Concern, Center for Responsible Tourism, and others focus on consumer awareness. Online portals such as Planeta.com, Ecoclub, and others have built awareness of the relation between conservation and tourism.

Tourism enterprises — in particular, nature-focused ones — can be an important tool to generate employment and income in under-developed, biodiversity-rich areas where few non-extractive options exist. This can be achieved with comparatively small investments (Wunder 2000). Moreover, many more people participate in tourism through micro, small and medium-size enterprises, such as selling crafts, food, or drink; via provision of cultural services such as displays, dancing, or traditional village visits; or by supplying inputs from locally-produced

food to accommodation facilities, or transport services to visiting groups (Roe et al. 2002). Poor people also receive other benefits related to tourism, including enhanced infrastructure and services in the form of health facilities, water systems, local security and communications, increased community income, and organizational skills to promote local change (Roe et al. 2002).

Community-based tourism enterprises have emerged in natural areas including parks in recent years. Ecuador, particularly, acts as a laboratory of indigenous community-based tourism (Wesche and Drumm 1999). In Costa Rica, studies show that communities near protected areas have incomes higher than those communities far from protected areas (Robalino and Villalobos-Flatt 2010). Similar benefits to communities have been shown around protected areas in Ecuador as well (Rodriguez 2008).

COMPARING BAU AND SEM: TOURIST INDUSTRY LIFE CYCLES

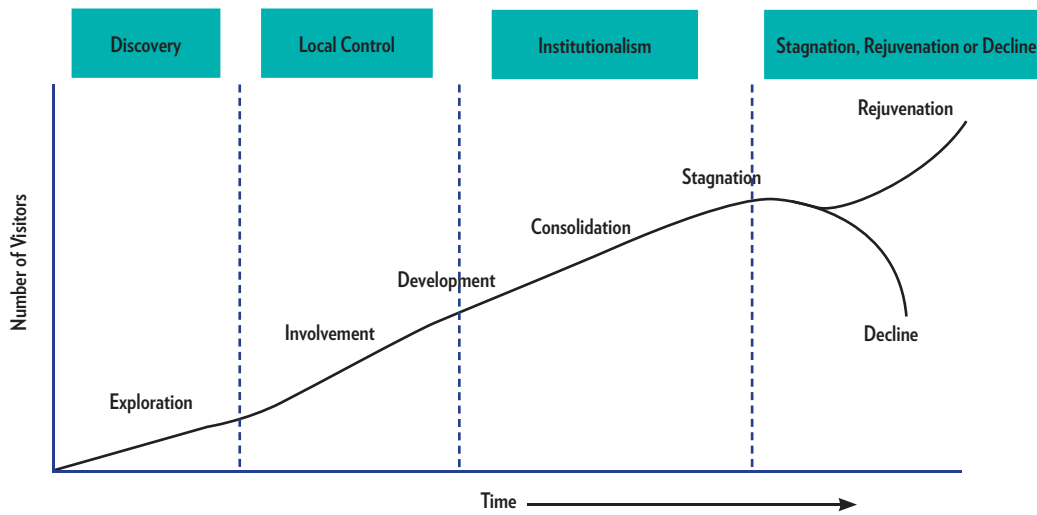
Inappropriate policies under BAU may shorten tourism destination life cycles: their evolution from discovery to full development and, later, eventual decline resulting from over-exploitation and deterioration of key attractions (Figure 9.3). In many countries, developed and developing alike, tourism sites are becoming overdeveloped to a point where environmental degradation and consequent revenue loss from a collapse in visitor arrivals is irreversible. Such 'non-renewable' tourism has been documented for enterprises ranging from a small fishing village in India's Kerala State (which saw tourism collapse after two decades of rapid growth due to inadequate disposal of solid waste) to Italy's Adriatic coast and Germany's Black Forest within the industrialized world (Neto 2003).

In general terms, the Butler Tourism Area Life Cycle curve can be adapted to the current context by projecting BAU for mass-based tourism following the decline curve and SEM following the rejuvenation curve (Figure 9.3). Rejuvenation is attained by a subset of BAU firms that are able to change course to SEM. Other enterprises will have started with a SEM approach, as suggested in Figure 9.4.

The life cycle diagram is based on the product cycle concept whereby sales of a product proceed slowly at first, then grow rapidly, stabilize, and, finally, decline. In the tourism context, visitors will come to an area or attraction slowly at first because of lack of access, advertising, and facilities, but as these improve, visitor numbers rise. With marketing, more facilities, and increased awareness, popularity will increase rapidly. Eventually though, capacities become saturated and visitor numbers decline. The limits may be environmental (e.g., resource degradation, land scarcity, water quality), physical (e.g., transportation, accommodation, or other services), or social (e.g., congestion, resentment by local people).

³¹ The Tour Operator Initiative (TOI) is a network of 25 tour operators that have committed to incorporating sustainability principles into their business operations and to working together to promote and disseminate practices compatible with sustainable development. The TOI was developed by UNEP, UNESCO, and WTO; TOI is coordinated by a secretariat and hosted by UNEP.

Figure 9.3. Butler's Tourism Area Life Cycle



Source: Butler (2006).

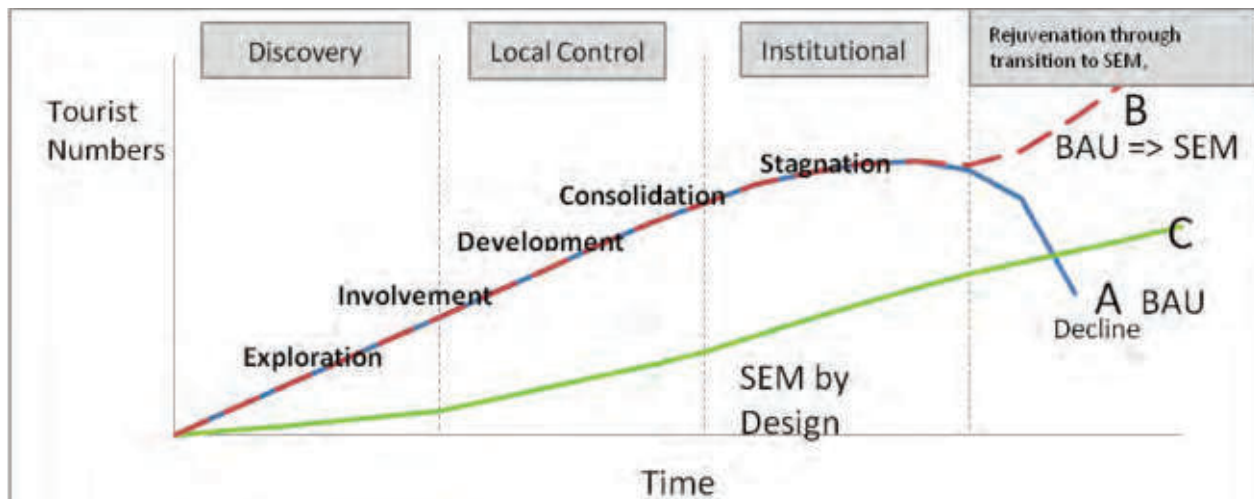
Rejuvenation of former BAU tourism destinations may occur in one of two ways: (a) by investing in a new attraction to a destination (e.g., casinos at Atlantic City, which originally was a beach site), or (b) by taking advantage of a previously unexploited resource to diversify the market or extend the season (e.g., summer destinations adding winter sports activities, or coffee plantations opening to both daytime and overnight tours in Colombia). Government and private sector efforts may be combined to pursue rejuvenation, thereby developing new attractions that reestablish competitive advantage, at least for a while.

When initiated under SEM approaches, tourism operations are less environmentally degrading and the attractive features are managed — much like a Bonsai tree — to avoid over-exploitation and to maintain their development in the consolidation stage, avoiding or delaying stagnation and decline. In LAC, the most significant unique attraction that most countries possess is their biodiversity and its nat-

ural attractions. No two countries are identical. Thus, to the degree that a country maintains its biodiversity in good health, while applying appropriate SEM development and management guidelines, this country can prolong its attractiveness in the market. Indeed, as global biodiversity continues to be reduced over time, the surviving biodiversity is apt to become increasingly valued by the tourism market as people strive to see what remains of nature. In this scenario, those countries that have best maintained their ES, biodiversity, and natural attractions will have an edge. Their prices for these opportunities can be maintained or raised over time in a way that BAU tourism is unable to do without constant rejuvenation.

In Figure 9.4, based on the Butler Tourism Area Life Cycle, we see how visitor numbers for BAU and SEM tourism may evolve. BAU tourism is characterized by larger, higher volume operations than newer SEM operations and destinations developed from scratch,

Figure 9.4. The Butler Tourism Area Life Cycle Comparing BAU and SEM



which we call here SEM by Design. Demand for SEM by Design tourism is predicted to continue to rise for the foreseeable future, eventually overtaking BAU tourism destinations that are expected to decline in terms of visitor numbers.

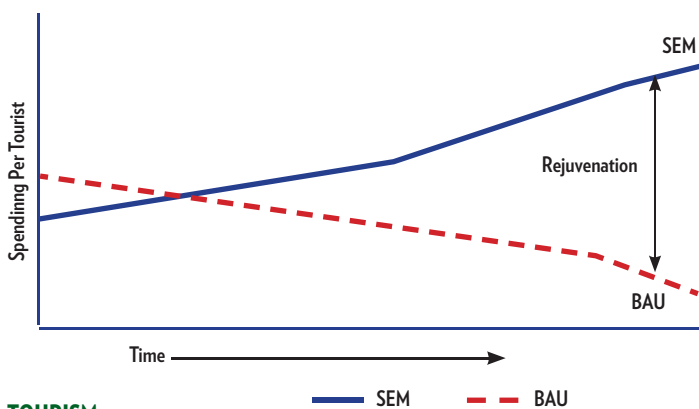
In the case of existing BAU tourism destinations, rejuvenation may be attained, as some hotel chains are now attempting this rejuvenation by transitioning to SEM through reductions in resource use and improved environmental management. This “SEM by Rejuvenation” is a second source of SEM operations.

If there is no transition to SEM, then volume and/or revenue, will ultimately decline (Curve A). Examples of this declining scenario are well known in LAC (see the Dominican Republic case study in Box 9.2) and include Acapulco and similar destinations. Transition from BAU to SEM results in rejuvenation (Curve B). The Curve B scenario is less widespread but emerging as destinations and some hotel chains adopt elements of SEM like water and energy conservation, as well as improved integration of nature-based tourism.

A third scenario (Curve C) shows SEM by Design tourism. Examples of this type of SEM include the new generation of tourism businesses and destinations that have been launched as sustainable from the start. Examples include private enterprises such as Tropic Journeys in Nature (Ecuador) and Rainforest Expeditions (Peru), as well as numerous community-based enterprises in the Amazon, Andes, and small cruise tourism in Antarctica. These enterprises purposefully attract lower volumes of visitors, but aim at better returns per capita. Figure 9.5 below shows the conceptual trends projected for spending per visitor over time for the BAU and SEM models of tourism.

The vertical axis is *Spending or Revenue per Tourist*. A very significant characteristic of SEM is that visitors consistently demonstrate a

Figure 9.5. Comparison of Per Tourist Spending for BAU and SEM



willingness to pay more for SEM experiences than for BAU, though tourist volumes will typically be lower under SEM than for BAU. The price differential with BAU will likely be maintained into the future as natural attractions become more widely appreciated, with growing demand for natural experiences leading to more effective organization, control, and management by governments and business. These stakeholders, increasingly, will recognize that comparative advantage in the tourism market place lies in the wellbeing of their natural attractions and in their relative scarcity.

Table 9.6 summarizes the concepts of this section, characterizing the four categories of tourism referred to throughout this chapter.

Table 9.6. Characterization of Recreational and Nature-Focused Tourism under BAU and SEM

BIODIVERSITY HOTSPOT/COUNTRY	BAU	SEM
RECREATIONAL	Largest market share in LAC High volume High density High leakage Lower revenue per tourist Low income multiplier Considerable negative externalities	Low but rising level of penetration Lower volume Lower density More use of local inputs Higher income multiplier Higher revenue per tourist ES maintained
NATURE-FOCUSED	Frequent congestion Over-use of attraction Passive community participation Negative impacts on natural areas ES degraded	Impacts monitored and managed Access limited Active community participation Higher income multiplier Higher spending per tourist ES maintained

It is useful to maintain the distinction between recreational and nature-focused tourism for the analysis of their comparative costs and benefits in the sections that follow.

9.5 ECONOMIC COSTS OF BAU

RECREATIONAL TOURISM

Historically, the financial success of tourism has come from mass tourism under recreational BAU, with the growth and impacts described above. But times are changing, driven by the accumulated effects of that model. The increasingly manifest downside that accompanies BAU has led public agencies and private investors to

question this tourism model. These effects are most easily visible in the Caribbean, which until recently was the principal destination in LAC in terms of visitor numbers. High volumes of tourists concentrated in a small geographical area and in smaller national economies has led to the generation of more acute impacts than in South America, where similar volumes of visitors are spread over much greater areas and focused on large cities such as Rio de Janeiro, Cusco, and Cartagena. The more visibly impacted beaches, reefs, and coastal areas of the Caribbean and the earlier emergence of a critical perspective makes this region the focus in discussing the impacts of BAU tourism.

Government Policy: Public Investment and Incentives

Since the 1960s, governments with support from the World Bank and international aid programs sought to promote foreign investment and export earnings by providing incentives to the BAU tourism sector. Tourism ministries, typically, focused on promotion of these conventional approaches. Only recently has the economic wisdom of this model been questioned for lack of penetration of benefits in the economy and the considerable negative externalities. Despite that questioning, the model tends to persist through a mixture of inertia and maintenance of vested interests. A particularly questionable policy issue in the Caribbean and Central America is the enticement of cruise lines to make stops at destinations via tax breaks and other financial incentives (e.g., 30-year concessions in the case of Roatan, Honduras).

Competition between countries is intense and yet the economic benefits to the economy as a whole through cruise tourism are very limited, possibly not even compensating the financial incentives on offer from competing destinations.'

Public investments in the provision of basic services (water, power, waste disposal) and infrastructure (airports, highways) are also powerful incentives that induce private corporations to invest at a given destination. The costs of these investments can be recovered through a variety of taxes and fees; but all too often these instruments take the form of subsidies to the tourism industry. As such, they tend to invite over-capacity and deform the response to market pressures; in that sense, they can be perverse subsidies.

Honduras has tax incentives for tourism investment both in conventional tourism and in projects that support nature conservation — i.e., supporting both BAU and SEM (Cafferata and Sierra

de Fonseca 2001). Although this “balanced” incentive is implicit recognition in one country of the potential importance of SEM to business, a predominance of pro-BAU incentives is more representative of governments across LAC: policy tends to reflect a lack of understanding of the degree to which tourism revenues depend on maintenance of ES.

Nature-focused tourism, on the other hand, has tended to develop in response to perceived demand. This success has been, more often, in spite of government policy than because of it (Cost Rica, perhaps being an exception). More recently, bilateral and multilateral aid agencies — including UNDP, USAID (The Nature Conservancy 2007), GTZ, IDB, and others — have invested in a range of nature-focused tourism projects in the region with biodiversity protection and poverty reduction objectives.

Development of the BAU model in many Caribbean Island countries has led not only to greater environmental and social insecurity but, ironically, also to economic insecurity. Tourism contributes less to the long-term economy than expected. In order to finance the large capital investments in infrastructure that are required under BAU — including large international airports, roads, sewage plants, landfills, electricity, and telephones — many Caribbean countries have borrowed heavily. Paying off those loans and the cost of maintaining

expensive new amenities has stretched some governments to the brink of bankruptcy. Some countries have required bailouts by the *International Monetary Fund* (IMF) (Gmelch 2003).

While the economic potential of nature-based tourism is growing, there is concern that this growth could be short-lived if not managed carefully. The long-term competitiveness of nature-based tourism is tightly linked to the health of the ecosystems on which the activity is based. When tourism is pursued through unsustainable operations that lead to degradation of the surrounding natural or social systems, this pursuit compromises economic returns over the long term. An example in the context of BAU recreational tourism is Acapulco, which a few decades ago attracted high-spending international tourists. As a result of over supply of hotel rooms, increased beach and bay pollution, and very high levels of prostitution and drug-related violence — all of which grew in the wake of this BAU model — visitor pro-

Since the 1960s, governments with support from the World Bank and international aid programs sought to promote foreign investment and export earnings by providing incentives to the BAU tourism sector.

files have changed dramatically; spending per visitor is much lower today. Further south, the profile of Belize as an emerging leader among ecotourism and nature-focused tourism destinations has been seriously undermined by its recent incursion into cruise ship tourism. In the space of five years Belize went from zero cruise passengers to over a million per year, with ensuing serious impacts in formerly well-maintained natural areas. Tourism operations that do not have safeguards to ensure low-impact operations can have detrimental effects such as habitat destruction and degradation. High levels of tourism are also associated with generation of waste, noise, air, and water pollution. Tourism can lead to an unequal distribution of economic benefits, and increase poverty through price inflation. And, BAU tourism may simply under-realize potential economic benefits through operations that promote leakage of revenues from a locality or country. The basic risk of maintaining BAU is the cost of the loss of long-term potential of natural areas to maintain ES and revenue levels, not just for the tourism sector but for the whole economy.

BAU CASE STUDIES

A series of case studies follows to illustrate different aspects of the BAU recreational model in LAC. An overview of the Caribbean, which epitomizes and is most committed to this model, highlights the issue of habitat loss and the associated negative economic implications. A study of the Dominican Republic goes deeper into some of the specific relationships between economy, environment, and social welfare in a destination characterized by mass tourism beach resorts. The Turks and Caicos Islands frame a study of the holiday-home side of recreational tourism. Last, is a study of the cruise ship sub-sector.

Recreational Model: The Caribbean Case

Caribbean tourism is dominated by three modalities: large coastal hotels and resorts, second homes, and cruise ships. These variants of the BAU recreational model have significant negative externalities. For example, mangrove forests have been cleared for resort development leading to loss of important seafood sources, commercially important fisheries, and coral reef attractions. Loss of mangroves has also exposed Caribbean coastlines to the full force of hurricanes with increasingly expensive impacts in terms of human suffering and commercial loss. In the Caribbean, tourist demand for potable water per capita ranges from five to ten times that of domestic residential users. Meanwhile, the ability of ecosystems to provide this service is diminishing due to pollution of inland aquifers (MA n.d.).

Of concern in the Caribbean are construction-related activities like coastline alteration, beach mining and replenishment, dredging,

and wetlands filling. Such activities impact environments in many ways. Shoreline structures like piers, jetties, and breakwaters alter sediment transport patterns, potentially preventing the rebuilding of beaches and, meanwhile, facilitating beach erosion and marsh destruction. Beach sand mining, a common practice in the region, causes siltation on coral reefs and other marine ecosystems. Similarly, dredging not only physically alters marine ecosystems, but also causes re-suspension of large amounts of sediment that decrease water clarity, affect photosynthesis, and stress corals and other suspension-feeders by making them expend energy to rid themselves of silt — or, in severe cases, smothering them. Biodiversity of corals, other invertebrates, fish, and algae is reduced as a result (UNEP-CEP 2001).

A financial consequence of BAU tourism-induced habitat loss is a rise in insurance premiums for coastal hotels and resorts. This is due to a negative feedback loop for the tourism industry, seen in places like Cancun, where hurricanes, freed of the protective influence of healthy mangroves and shore vegetation, have led to near-total loss of the beaches that are a main factor in attracting tourism. The environmental impact of this habitat loss is extended via mining sand in other places in an attempt to replace the lost beaches at Cancun. The process of beach “renourishment” is a practice widespread in the Caribbean. Financed by governments, beach engineering consists of extracting sand from one site to replace it at another where the sand has been eroded, either naturally or due to construction. In effect renourishment is an expensive subsidy for BAU, the effects of which are frequently short-term since the processes that promote erosion continue.

Beach Resort Sub-Sector

The economic profile of recreational BAU tourism is analyzed by taking the case of the Dominican Republic, one of the principal destinations for recreational tourism in the Caribbean. The Dominican Republic received 4 million international visitors in 2008 (WTO 2009), 20% of the entire Caribbean market. It might be said that the DR is the archetypal example of BAU in the region (see Box 9.2)

Residential Tourism Sub-Sector

The following case study is divided into two parts. Part one (Box 9.3) summarizes the situation in the Turks and Caicos Islands where the emerging recreational BAU tourism development model, dominated by the vacation homes modality, threatens ecosystem integrity and economic benefits. Part two (Box 9.8) quantifies the economic benefits of the current tourism model. Residential tourism, along with resorts and cruise ships, are one of the principal tourism types in the Caribbean and increasingly in Central America, at places such as the Pearl Islands and Bocas del Toro in Panama.

Box 9.2. Economics and Impacts of BAU Recreational Tourism in the Dominican Republic

The share of the Dominican Republic in the regional market has significantly increased. In 1990, this share was 11% of the regional market. By 2008, hotel accommodation had peaked at over 66,000 rooms (WTO 2008), the largest of in the Caribbean destinations — almost five times the capacity of Puerto Rico, twice that of Jamaica and Cancun, and 35% above Cuba.

Tourism in the Dominican Republic, as in most Caribbean countries, focuses on sun and sand tourism, leveraging the weather and natural conditions; Bávaro-Punta Cana and Puerto Plata-Sosúa are its major tourist hubs, with their own international airports. In 2000, 78% of the country's hotel rooms (UNDP 2005) were concentrated in those two areas, most in hotels with over 400 rooms. In 2008, these two hubs received jointly over 60% of the international arrivals.³²

Large, all-inclusive beach resorts and hotels have been the fruit of public policy and direct private foreign investment. This enclave model, which seeks to exploit the mass sun and sand markets with economies of scale, has produced significant results from the macro economic standpoint for the Dominican Republic. Tourism's contribution to GDP³³ (UNDP 2005) increased from 1.3% in 1980 to 8% in 2003. Employment data is also relevant — the generation of direct and indirect jobs has moved from 1.4% of the country's economically-active population in 1980 to 5.0% of the EAP in 2003.

However, several indicators show this model is not sustainable. Benefits achieved to date are not likely to continue in the medium and long term. From an environmental standpoint, coasts, beaches and reefs—the principal attractions for the industry—are degrading due to the direct and indirect effects of tourism. About 30% of coastal pollution is attributable to the hotel industry (UNDP 2005) due to the high volume of sewage generated that is dumped in the basins and coasts. Coral reefs are degrading as a result of groundwater pollution from the use of fertilizers and pesticides for the maintenance of golf courses (López Gómez 2007) and from sedimentation caused by creation of artificial beaches. Freshwater and electricity are being used inefficiently: hotels in the Dominican Republic use 412 gallons per guest/night, 2.8 times the best practices standard set by Green Globe 21, and almost twice the average for Caribbean hotels. Maintenance at golf courses consumes about 8 million m³⁴ yearly—twice the amount used by the industrial sector over the same period. This intensive water usage is depleting water reserves dramatically, competing directly with local usage. In terms of energy, consumption per guest/night is 33.53kW, 5.5 times higher than the best practices standards.

As a result of draining wetlands, destruction of mangroves, and carelessness with environmental considerations when extending beaches and building beach hotel complexes, the vulnerability of these investments to extreme weather events has increased.

Steps taken to reduce the negative impacts of this BAU model are limited; recent Oxfam (2007) and UNDP (2006) publications stress that the level of control of and compliance with environmental rules on the construction and operation of hotels and other tourism-supporting infrastructure has been low; there are no signs of a major policy change. Nor does the private sector seem to be assuming any measures to make tourism activities more sustainable: by 2007, only two of 300 hotels in Punta Cana-Bávaro actually had the legally-required environmental permit (López Gómez 2007). Fewer than 10 hotels are members of sustainability certification programs for their operations.³

In economic terms, some indicators provide evidence of the low sustainability of the model; per tourist profitability is decreasing. Though international demand is skyrocketing, tourist expenditure in real terms (UNDP 2005) dropped by almost half between 1985 and 2003. According to UNDP's (2008) Human Development Report, this trend persists: "the yield resulting from tourism, measured in terms of foreign currency inflow per tourist and per room in actual terms has been declining, whereas total income is increasing as a result of the increase in the number of incoming tourists. This has translated into higher environmental costs and negative externalities for the country." A major portion of foreign earnings from international tourism exits the country. Some studies point out that 50% to 80% of spending at all-inclusive hotels leaves the destination economies (López Gómez 2007). A significant part of the hotels in the DR are owned by international chains; marketing and air transportation are also operated by foreign companies.

From a social perspective, there is also data that leaves room for questioning the model's sustainability: though there is significant generation of employment, the quality of the jobs created is low. The average salary in the industry is 16% below the national average; over 70% of the jobs require little qualification; and this is even worse in the case of women, who earn 32% less than men and over 80% of whom are employed in positions requiring little qualification (Oxfam 2007). As for the integration of the host community into tourism, there is a dramatic divide as shown by the exclusion of local people from the decision-making process and from access to beaches — theoretically considered to be public property, but which in practice are private.

In 2009 and 2010 the Dominican Republic government, through the Ministries of Tourism and of Environment, have carried out their first trainings for staff and for industry representatives in sustainable tourism.

³² Estimate based on 2008 data from the Central Bank of the Dominican Republic, considering the airway arrival of non-resident visitors.

³³ 1980 \$-based actual income.

³⁴ Estimate based on eco index data.

Box 9.3. Economic Value of Biodiversity and Ecosystem Services for Productive Sectors in Turks and Caicos Islands
(For part 2, see Box 9.8)

The Development Conundrum

The Turks and Caicos Islands form a fragile low-lying barrier along the edge of the Atlantic Ocean. Up until very recently, the effects of human occupation have been minor and hard to identify. For the last several hundred years, the islands provided home to a resident population fluctuating between 4,000 and 6,000 people. In the late 1960s, a group of investors took a long lease on a large area of what was then a lightly settled island—Providenciales. Soon there was an airstrip, a road, a marina, a hotel. The area was subdivided and lots sold to developers and individuals.

There are no simple ways to determine the cost of such BAU over-development, but three economic indicators may suffice:

- reduction in the number of holiday-makers to the islands and in the sums spent, as the quality of the holiday experience falls short of expectations
 - fall in property values as demand weakens due to crowding, declining environmental quality, and failure to uphold environmental standards;
 - reduced inward investment in the development of existing and new residential and hotel plots as investor confidence weakens.
- hotels and restaurants contributed \$222 million to GDP in 2007 (about 1/3rd of GDP); a 10% fall in visitor numbers would be a loss of \$22.2 million to the economy. A further 10% reduction in the cost of holidaying in TCI would be a further \$20 million loss.
 - adversely affects investor confidence and the value at which houses are sold, reducing the amount transferred to government in the form of stamp duty
 - several thousand homes have been built and are owned by outside investors, but at least as many residential lots owned by national and outside investors, are as yet undeveloped. They will remain so if confidence is weak.

Prepared by Crick Carleton.

Note: The author would like to acknowledge the support of the DIFD UK and the Turks and Caicos Islands Government, and particularly the support from the staff of the Department for the Environment and Coastal Resources (DECR), TCI, most notably Michelle Fulford-Gardiner and Rob Wild. The four pieces of work undertaken by Nautilus Consultants on which this case study draws were done by Crick Carleton, John Hambrey, and Keith Lawrence assisted by Marsha Pardee, Kathleen Wood, and Lorna Slade.

By 2000, the resident population had risen to 20,000, and by 2008 the figure was 30,000 — mainly due to outside investors making their primary or secondary homes on the islands, but also drawing in the staff, managers, and services needed to support the booming tourism industry. Providenciales is now in the top rank of holiday destinations, with visitor numbers increasing from 160,000 in 2004 to 300,000 in 2008. Along with the burgeoning array of hotels and condominiums, shopping malls, bars, and restaurants, a more recent addition has been a cruise ship terminal, established on Grand Turk in 2007. And, while the original concept was of luxury, environmentally low-rise (maximum of three stories) and low-impact hotels and holiday homes, more recent development has seen more obtrusive five and seven story condos and hotels built at Grace Bay, Providenciales, alongside the islands' premier Princess Alexandra Marine National Park. The potential for over-development that characterizes recreational BAU is all too evident.

Cruise Ship Sub-Sector

A sub-sector of the traditional BAU mass tourism model that is particularly relevant in LAC is cruise ship tourism. This type of tourism is worth \$20 billion/year in sales, with 50% of that generated by Caribbean cruises. Another notable characteristic of the cruise industry is that 85% of the market is managed by just three companies — Royal Caribbean, Carnival, and Norwegian. Countries that have a notable cruise ship sector include St. Thomas in the US Virgin Islands, Mexico (Cozumel), Cayman Islands, Belize, and St. Martin.

There are indications that the importance of transitioning from BAU to SEM is being understood within the industry. At least one of the big three cruise companies recognizes explicitly the critical contribution of healthy ecosystems to the success of their business and agrees that the Caribbean cruise industry is recreational, but depends on ES for its well-being, e.g., healthy beaches, and reefs (Sweeting 2009).

However, BAU continues to predominate. In Belize, 77% of all visitors are now cruise ship passengers, yet their spending amounts to only 18% of the country's tourism revenues (CESD 2006). Congestion at the main tourism destinations generated by cruise passengers reduces the quality of the visitor experience for stayover tourists who spend five times more than cruise ship visitors (CESD 2006). At the same time there is a strong perception among the sector's stakeholders that most of the cruise passenger spending stays in the hands of cruise ship companies and a limited number of Belizean companies, thus creating only a very limited economic impact in the local economy.

The costs of BAU described in these country case-study boxes have a curtailing effect on a country's potential to develop SEM *nature-focused* tourism, as might be expected. Though BAU costs are still alarmingly ignored, this reduces the potential for the tourism sector to diversify and thus be more able to withstand changing economic climates and market fluctuations. For example, turtles, hugely attractive for dive and snorkeling tourism, are endangered in the region and increasingly rare to see at Caribbean dive sites. That is a result of the destruction of nesting sites by BAU coastal tourism development and by disruption to reefs caused by sedimentation and by sewage generated by coastal hotels.

Reef biodiversity has declined precipitously, due in general to these same causes with consequent reduction in the quality of the snorkeling and diving experience. Demand until now has been inelastic with only repeat divers and local NGOs aware and concerned about how the quality of the resource has declined over time. But if past trends continue, a drop off in demand for snorkeling and diving is likely as tourists seek alternative destinations. A study of reef attributes and scuba diver behavior in Roatan, Hon-

duras, shows that marine environmental quality, measured as percent live coral cover, is a significant predictor of dive site visitation. The regression results support a simple utility maximization model that demonstrates how coral reef degradation can reduce diver satisfaction and harm local economies (Pendleton 1994).

Golf course development is a type of recreational tourism with particularly noxious impacts on coastal ecosystems in the Caribbean because of large volumes of chemical fertilizer and pesticides that run off in heavy rain into the reefs and mangrove areas (Mason 2010). An 18-hole golf course requires clearing at least 90 acres; wetlands are often filled in to facilitate their development. An average course requires around 1 million gallons of water a day (Sweeting, Bruner & Rosenfeld 1999), enough to meet the daily requirements of thousands of local people. Consequently, potential for SEM tourism is reduced by golf course development

Nature-focused Tourism: BAU Approaches

While *recreational* tourism continues to dominate in terms of total visitors and revenues, the past two decades have seen the emergence of a fast-growing *nature-focused* tourism model. Costa Rica thrust itself to the forefront of this phenomenon in the late eighties by investing heavily in a marketing strategy that highlighted its comparative advantage in the market – high biodiversity – and exploited the growing interest in the North American public to see and experience nature first hand. This proved to be a tremendously successful strategy for Costa Rica, even though many of competitors and neighbours had higher indices of biodiversity and were more culturally diverse. Other countries have since had similar dramatic success in creating a nature-focused tourism sector by engaging their high biodiversity, natural features, and cultural diversity to exploit this emerging market. This has been an astute tourism alternative in countries such as Ecuador, Peru, Chile, and Bolivia, all well endowed with biodiversity but too far from mass markets to be competitive in the high volume, low profit margin recreational model.

Nature-focused tourism is not synonymous with ecotourism. This tourism model is not, in virtue of its nature focus, necessarily sustainable, though it is often confused as such in the media and in marketing materials. Nature-focused tourism, like recreational tourism, exists on a spectrum between BAU and SEM. Currently, most nature-focused tourism is toward the BAU end of the spectrum. Indeed, The Nature Conservancy identified tourism as a major threat in 78 conservation plans for protected natural areas, mostly in the LAC region, which it has produced over the last seven years (Drumm 2008).

There are many examples of BAU nature-focused tourism, such as the case of Salar de Uyuni in Bolivia (Box 9.5), which also highlights strategies for transitioning to SEM.

Box 9.4. Cruise Tourism in Roatan, Honduras: BAU Recreational Tourism

Roatan is a prime tourist destination in Honduras, one of the Bay Islands located off the north coast. Well known internationally, Roatan provides the opportunity to enjoy the Mesoamerican reef — the second largest in the world — through diving and snorkeling.³⁵ Cruise tourism is an emerging activity in the island, greatly boosted by the government since the beginning of this decade to promote development of a massive tourism model in Roatan.

The flow of cruise tourists to the Island has risen rapidly, from 54,000 in 2001 to 434,000 in 2008, but the goal is to keep increasing the flow. In February 2010, Carnival Cruises opened the largest cruise port in Central America, at Mahogany Bay, with a \$70 million investment. Honduran authorities expect 800,000 cruise tourists (La Prensa 2010) in 2010, doubling the number reached in 2008. Arrival of new international hotel chains and the construction of golf courses are expected, estimated to bring private investments of more than 150 million dollars.

These initiatives are supposed to dramatically increase the economic tourist-sourced benefits enjoyed both by the island and by the country. However, there is uncertainty about the net benefits to be generated by tourism, taking into account the economic, social, and environmental costs resulting from this development of large-scale tourism.

Such an increase in the number of cruise tourists will entail a larger foreign currency inflow, but also greater environmental impacts. The average cruise tourist's expenditure is 100 dollars, only 16% of the expenditure of a stay-over visitor, which means that 800,000 cruise tourists expected for 2010 will spend an amount equivalent to the expenditure of about 130,000 stay-over tourists. This data show that the development of cruise tourism is increasing its environmental footprint on the Island by a factor of at least six times. This means intense pressure on freshwater resources and an increase in the generation of solid waste and sewage, resulting in faster coral reef degradation. Surveys conducted from 2000 to 2005 show that these reefs are being degraded by rising sea temperatures, the pollution and sedimentation produced by tourism development, and from inappropriate diving and snorkeling practices.

A significant part of the expenditure from cruise tourists on their visits to Roatan will not remain in the local economy, implying reduced net economic benefits for islanders. Despite that, the local population will be more exposed to the high social and environmental costs resulting from this development model. Investment in cruise tourism in Roatan is mostly by foreign firms, which results in repatriation of profits to investor country of origin. Half of tourism-generated revenues in developing countries is estimated to exit their economies (Mowforth and Munt 2000). In cases where foreign investment is prevalent, this can amount to 85%. A study carried out in 2007 indicates that 57% of the tours made in Roatan were purchased on board (CESD- INCAE 2007). That way, cruise companies get 50% of the spending by tourists on activities on the island. That same study points out that “almost 35% of the total amount paid by the passenger reaches local businessmen, workers, or is used for paying the local facilities.”

Expansion of BAU tourism across the island will produce social and environmental costs for the local population. The gap between rich and poor is likely to widen, because the businesses that benefit from this activity are controlled by a few (six families on the island) (CESD- INCAE 2007). The remaining population benefits from tourism through employment; in many cases as unskilled labor or by sales of inputs such as seafood. The growing demand for fish has caused damage to the mangroves and reefs, thus endangering the quality of ecosystems on which most of the local people depend. Migration from the mainland is inflating land prices and putting pressure on social services.

Although some of these environmental, economic, and social issues were already present in Roatan, the pressure to which island ecosystems and society are being subjected by the pace at which cruise tourism is growing puts in doubt the sustainability of the net benefits from this kind of tourism development. The gains for the local population and the economy of Honduras are at risk. It is doubtful whether there is still opportunity to make this tourism development model sustainable. Also questionable is whether it was the right decision to permit such intensive use of limited natural resources, especially when, with some adjustments already under way, the previous model — which was closer to SEM — might have brought about better distributed and more sustainable benefits.

Prepared by Juan Rene Alcoba

³⁵ In 2002, Roatan had 31 diving centres, according to the “Preliminary assessment of tourism activities vis-à-vis natural resources” prepared for the Environmental Management of Bay Islands Project (2002).

Box 9.5. The Salar de Uyuni and the Eduardo Avaroa Reserve (Bolivia)

Bolivia's principal tourism destination had over 80,000 visitors in 2009. The absence of management tools and capability is generating negative impacts, including erosion of fragile soil by off-road vehicles, accumulation of human waste at the site of key attractions in the absence of toilets, and limited benefits for local communities. The tourist attractions, as the volume of visitors suggests, are spectacular. Yet the tourism product is poorly conceived, with local businesses charging as little as \$3 per person per night for accommodation, while studies show visitors prepared to pay almost \$50/person/night for adequate services and better managed and conserved natural resources (CSF - UMSA 2007). Another study at the same site shows that visitors are willing to pay significantly more (\$20) for the entry fee, currently \$4 (Drumm 2004). With such an increase, funds would be available to build capacity to manage the negative externalities of tourism and improve the quality of visitor experience without undermining demand.

St. Lucia visited coral reefs at some point during their trip. The direct economic impact from related visitor spending on accommodation, reef recreation, and miscellaneous expenditures was estimated at 11% of total GDP in St Lucia and 15% in Tobago, which is about a fourth and a third, respectively, of the tourism contribution to country GDP. Additional indirect economic impacts, driven by the need for goods to support reef tourism, were estimated to contribute a substantial additional sum to the national economy in both places (Burke et al. 2008). In Belize, coral reef- and mangrove-associated tourism contributes an annual \$150 million to \$196 million to the national economy, comprising 12-15% of GDP (World Resource Institute 2008).

Box 9.6. Ecolodges and Biodiversity

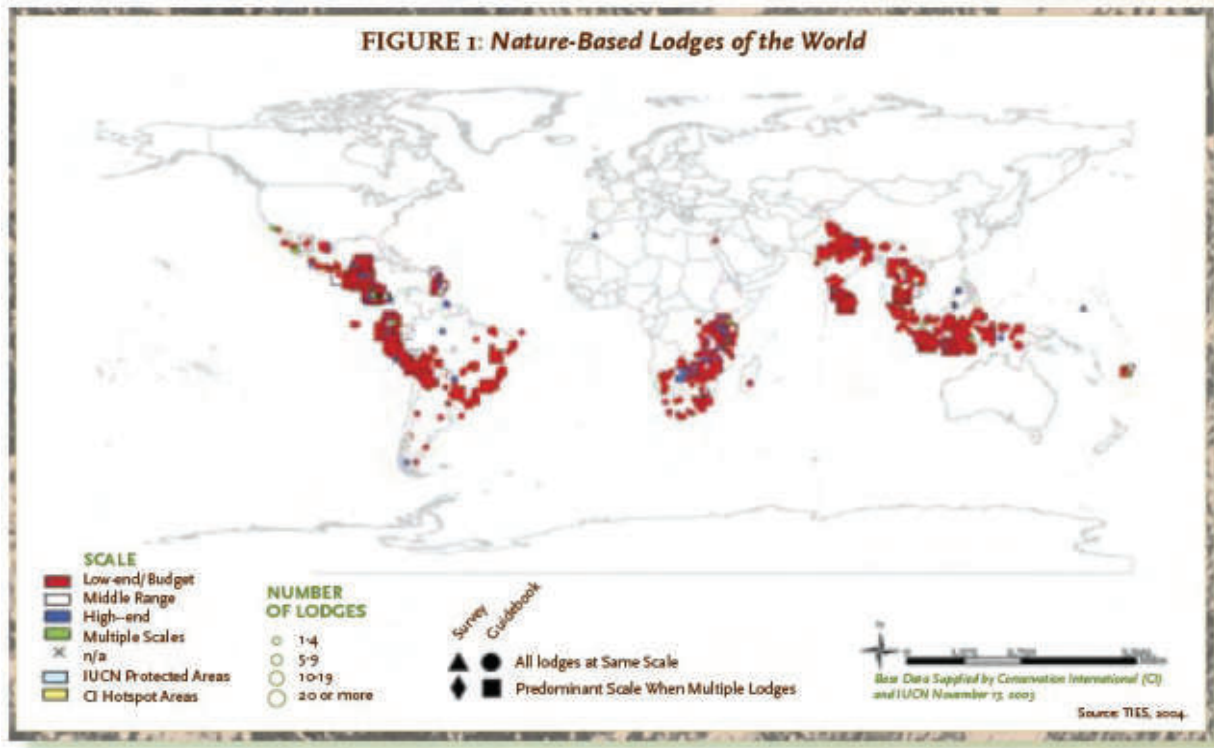
There is a strong correlation between the location of ecolodges and that of public and private protected areas or areas of high biodiversity. The Ecolodge Footprint study mapped the locations of nature-based lodges in 60 countries (based on a review of guidebooks) as well as those of 106 ecolodges that completed written surveys. The 60 countries were chosen based on their high concentration of nature-based lodges, their developing or mature ecotourism industry, and their location in an area of high biodiversity or related natural attraction. Of the total 5,459 lodges mapped (another 1,059 could not be plotted because no location was available), Indonesia has the largest concentration (758), followed by Costa Rica (590), Thailand (468), Peru (356), Ecuador (345), Guatemala (322), Mexico (304), Sri Lanka (277), and Tanzania (259).¹ Of the lodges mapped in all 60 countries, 84% are located in biodiversity hotspots, as defined by Conservation International. The highest concentration is in Mesoamerica (1,157), followed by Indo-Burma (543). Of those lodges that completed the surveys, 60% are located within or on the periphery of an established protected area, and 39% are within a private reserve. The many ecolodges and nature-based lodges located in or near areas of high biodiversity value suggests the need for lodges to maintain sound environmental standards. Since effective government regulation and voluntary certification programs are fairly rare (only 26% of lodges completing the survey had a green certification or rating), environmental, as well as both social standards and practices are often developed by lodge owners and managers. The IFC gives an overview of the 5,459 lodges mapped in 60 countries (see Figure).

Ec lodges

Nature-focused accommodations, designed to respond to demand for appreciation of nature, are a widespread trend. They are frequently known as *Ec lodges*. Box 9.6, largely taken from an IFC report (IFC 2004) elucidates the scale and nature of this particular segment of nature-focused tourism and is a significant indicator of the importance of biodiversity to the tourism sector. However, being described as *Ec lodges* does not define clearly where they lie on the BAU-SEM spectrum. Some lodges have been designed with a high degree of care and attention to both sustainability and local community engagement (indeed, many have community equity); others have sought to exploit biodiversity as an attraction, while at the same time creating environmental and socio-cultural problems, for example, poor waste management and lack of community engagement.

Coral Reefs

Coral reefs sustain and enrich the tourism product of much of the recreational tourism sector hosting nature-focused activities like snorkeling and scuba diving as a complement to more recreational products. The value of healthy coral reefs to the recreational tourism sector is enormous. In 2006, 40% of visitors to Tobago and 25% to



Source: International Finance Corporation (IFC) 2004.

1 See the full Ecolodge Footprint and Justification for Biodiversity Conservation study, available at www.ifc.org/ebfp.

Coral Reefs

Coral reefs sustain and enrich the tourism product of much of the *recreational* tourism sector hosting *nature-focused* activities like snorkeling and scuba diving as a complement to more recreational products. The value of healthy coral reefs to the recreational tourism sector is enormous. In 2006, 40% of visitors to Tobago and 25% to St. Lucia visited coral reefs at some point during their trip. The direct economic impact from related visitor spending on accommodation, reef recreation, and miscellaneous expenditures was estimated at 11% of total GDP in St Lucia and 15% in Tobago, which is about a fourth and a third, respectively, of the tourism contribution to country GDP. Additional indirect economic impacts, driven by the need for goods to support reef tourism, were estimated to contribute a substantial additional sum to the national economy in both places (Burke et al. 2008). In Belize, coral reef- and mangrove-associated tourism contributes an annual \$150 million to \$196 million to the national economy, comprising 12-15% of GDP (World Resource Institute 2008).

Protected Areas

The rapid growth and scale of visitation to protected areas are excellent indicators of trends in the nature tourism market. Studies from

Mexico, Belize, Dominica, Costa Rica, and Ecuador, carried out in the past 10 years, indicate that for 50 to 70% of tourists, protected areas were an important factor in their choice of destination (Boo 1990). Even as far back as 1991, a survey of tourists in Quito's international airport found that 76% placed 'natural history' as their main reason for visiting Ecuador. Furthermore, 65% stated that protected areas were their principal reason or an important influence (Drumm 1991).

In Mexico, CONANP estimated that some 5.5 million tourists (about one quarter of all visitors) visited federally protected areas in 2006; \$286 million were derived exclusively from direct payments related to their visits — 2.3% of international traveler expenditures for the entire country. TNC predicts this figure could be closer to 14 million national and international visitors annually, and direct expenditures closer to \$660 million per year (5.5% of international traveler expenditure) (CBD 2008). In Costa Rica, park-generated tourism is the second largest industry in the country (Dudley et al. 2008). In Argentina, about 60% of international tourists visit a protected area. In Chile, 59% of foreign tourists relate visits to nature-based tourism. In Ecuador, 58% of international tourists have nature and wildlife as their main reason for visiting, and in Peru 71% of foreign visitors go to protected

areas. Given that, clearly, the natural values of biodiversity and natural landscapes motivate this visitation, it is critical that tourism in protected area be managed sustainably to maintain their attractiveness as destinations. However, the negative impacts of BAU nature-focused tourism are manifest as much in protected areas as outside them. Yet as the resources within them are protected and therefore considered to be more valuable than those outside, it can be said that the cost of BAU in protected areas is higher. In the following sections, strategies for turning protected area BAU practices into SEM practices at low cost are described.

Finally, it is necessary to address the implications of climate change for the tourism industry, not the least being that travel and tourism is an important contributor to greenhouse gases.

The Economic Impact of Climate Change on Tourism

Climate change can have a major effect on global patterns of tourism because environmental considerations are a significant component of tourist decision-making regarding holiday destinations (Braun et al. 1999). In some locations, increasingly favorable climatic conditions for tourism could have a beneficial impact on local economies if tourists respond to these changes by altering their choice of destination. However, changing climatic conditions and consequent environmental changes such as increased frequency of storms and other extreme events may also reduce the attractiveness of some holiday destinations, as the outlined in Box 9.7. Rising prices for travel will also affect destination choices as higher costs of fuel and of diverse mitigation measures come into play. Preferences will change as travelers adopt greener attitudes and the industry moves toward more sustainable-sounding stances: for instance, cruise ship transport may be presented as an energy-efficient alternative to air travel.

It is clear that the tourism sector can make a contribution to mitigating the worst aspects of climate change — in part induced by tourism itself — by improving fuel efficiency and transitioning to non-fossil fuels for aircraft, but also by improving the resilience of biodiversity and ES to withstand the pressures of climate change. The sector can also experiment with more sustainable stances, such as encouraging local exploration first, using fewer but longer lasting visits for distant places, and switching to more efficient modes of transport — trains instead of cars, ships instead of planes, walking and bicycling within destinations. These action will be supported as public

awareness and attitudes are cultivated in environmentally-sound and cost-efficient directions.

9.6 TRANSITIONING TO SEM: CASE STUDIES

Distinguishing between recreational and nature-focused tourism models, as done when reviewing the costs of BAU, continues useful for addressing a series of cases and examples of SEM below.

SEM RECREATIONAL TOURISM

As noted above, SEM tourism follows two pathways: SEM by design and SEM by rejuvenation of BAU enterprises. In the case of the traditional recreational model, given the scale of negative externalities already generated in many localities under BAU, SEM by rejuvenation may only be achievable with large investments in restoration of beach, reef, and mangrove habitats, since so much natural capital may already have been lost. Besides such investments in recuperating natural capital, it will be necessary to reduce the environmental footprints of the current and projected facilities, potentially including the reduction of hotel densities at overbuilt destinations such as that undertaken by the Spanish government in Mallorca. Initiatives such as Green Globe, Blue Flag, Rainforest Alliance (see Box 9.14), CAST, and others (see e.g., UNEP 1998) are working with the industry to reduce its footprint. Active participation in such programs BY a country's tourism industry where the recreational tourism model predominates, together with effective land use planning in coastal and other natural areas should be considered a minimum for progressing towards an SEM model. Currently less than 1% of tour operations are certified; critical mass has yet to be attained. The process to date does illustrate that tourism's relationship to biodiversity and ES is not necessarily static but rather

dynamic. Market demand for sustainable products is widely reported to be growing, and the industry will likely continue to evolve in response.

Such changes from BAU appear to be attractive in the market place: more tourists are selecting holidays which feature local cultural experiences. Furthermore, tourists are attaching increasing importance to ethics and the corporate social responsibility of an operator. The

Rising prices for travel will also affect destination choices as higher costs of fuel and of diverse mitigation measures come into play.

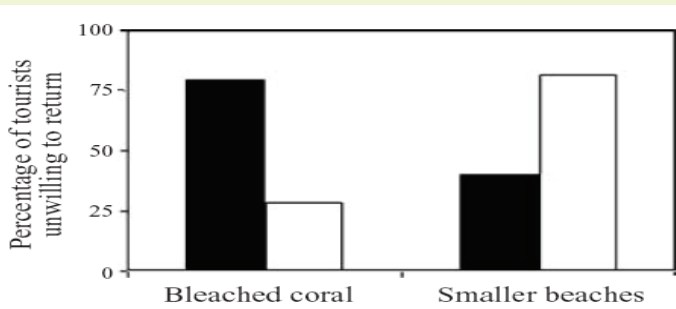
Box 9.7. Island-specific Preferences of Tourists for Environmental Features: Implications of Climate Change for Tourism-Dependent States³⁷

Climate change can affect the economy of a country. Sea-level rise is likely to cause flooding of coastal areas and affect infrastructure (Mimura 1999; Parsons and Powell 2001). On tropical coasts, where environmental features like warm temperatures, coral reefs, and beaches are strongly promoted by the tourist industry, global warming could impact economies that depend heavily on tourism (Braun et al. 1999; Agnew and Viner 2001).

Climate change may affect important environmental components of holiday destinations, with potential repercussions for tourism-dependent economies. The importance of environmental attributes in determining the choice and holiday enjoyment of tourists visiting Bonaire and Barbados, Caribbean islands with markedly different tourism markets and infrastructure was shown by Uyarra et al. (2005). Warm temperatures, clear waters, and low health risks were the most important environmental features determining holiday destination choice. However, tourists in Bonaire thereafter prioritized marine wildlife attributes (i.e., coral and fish diversity and abundance) over other environmental features, whereas tourists in Barbados exhibited stronger preferences for terrestrial features, particularly beach characteristics (Uyarra et al. 2005).

The willingness of tourists to revisit these islands was strongly linked to the state of the preferred environmental attributes. More than 80% of tourists in Bonaire and Barbados would be unwilling to return for the same holiday price in the event of coral bleaching (a result of elevated sea surface temperatures) and reduced beach area (a result of sea-level rise). Climate change might have a significant impact on Caribbean tourism economy through alteration of environmental features important to destination selection (see Figure).

Percentage of Tourists Unwilling to Return to Bonaire (filled bars) or Barbados (open bars) at the same Holiday Cost if Coral Bleaching or Beach Loss Occurs as a Result of Climate Change.



³⁷ This case study is adapted from Uyarra (2005).

Economic impacts of changes in preferred environmental attributes

There is already some evidence that the Caribbean climate is changing in ways that may affect tourism. Mean atmospheric temperature in the eastern Caribbean has increased by 0.2–0.4C per decade since 1976; recent models indicate that temperatures will rise by 1.4–5.8C in the next century (Intergovernmental Panel on Climate Change 2001). Such changes might cause discomfort for tourists (Balafoutis and Makrogiannis 2001; Morabito et al. 2005; Zaninovic and Matzarakis 2005) or foster the spread of disease-transmitting mosquitoes (Hopp and Foley 2001).

Higher sea temperatures have been linked to coral bleaching (Hoegh-Guldberg 1999; Reaser et al. 2000), which affect reef fish composition and aesthetic values of coral reefs (Wilkinson et al. 1999) as well as net revenue of some diving resorts (Cesar 2000). Hurricane frequency, intensity, and seasonality may be altered (IPCC 2001). The impact of this on beach erosion is not clear, but coastal development and the building of protective piers may restrict the scope of beaches to retreat landward in the face of storm surge and sea-level rise, causing a reduction in beach area with potential economic and biodiversity consequences (Cambers 1999; Fish et al. 2005).

As tourism-dependent islands, the economies of Bonaire and Barbados may be particularly vulnerable to climate change. Tourism in Bonaire is growing by 7-10% annually (UNESCO 1997) and provides 40% of the GDP of the island (F. Simal, personal communication 2002). By contrast, the economy of Barbados is more diverse, with tourism contributing 12% to GDP (Sealey 2001). The islands differ greatly in their tourism strategies. The mass model of beach-oriented tourism of Barbados contrasts with the more environmentally-friendly tourism in Bonaire, based on its pristine coral reefs (Dixon et al. 1993). These distinct strategies should give rise to contrasting clienteles with different levels of interest in environmental features that are potentially affected by climate change.

The environmental attributes valued by tourists in choosing a holiday destination may be altered by a variety of means and lead to shifts in travel destinations (Braun et al. 1999; Agnew and Viner 2001; Lise and Tol 2002). For example, natural disasters and over-exploitation of resources clearly reduce environmental attractiveness. Tourism can also negatively impact itself, both through crowding, which deters some tourists, and by building infrastructure that can accelerate degradation of attractive natural features (Tisdell 1991; Davis and Tisdell 1995).

Many environmental attributes will also be affected by climate change; many such impacts are expected to harm the tourism

industry (Wall 1998). For example, 80% of tourists indicated that they would be unwilling to revisit their holiday island for the same price if their preferred environmental features (i.e., coral reefs for Bonaire) were affected negatively by climate change. For instance, a marked reduction in the number of divers visiting a popular resort in the Philippines was noted following the mass-bleaching event of 1998 (Cesar 2000).

Tourists can thus respond

Box 9.7. (conclusion)

strongly to changes in environmental conditions. Given that 40% of visitors had previously visited Bonaire or Barbados, the economic repercussions of climate-induced shifts in holiday destinations could be severe.

Because coral bleaching and beach erosion are likely to occur regionally, environmental features on other Caribbean islands vying for tourists will also be affected. However, localized variation in weather patterns, geology, and in both reef and beach structure may result in increased coral bleaching or lost beach area on particular islands but not others. In addition, many respondents indicated a willingness to return to Bonaire or Barbados at a cheaper price, should reefs or beaches be adversely affected by climate change (Uyerra 2002). Climate change could also result in more favorable climatic conditions, which may attract tourists.

The relative attractiveness of Caribbean islands to tourists may thus be altered by climate change, but impacts at individual places cannot currently be predicted (IPCC 2001). Nevertheless, the economic repercussions of climate-induced changes in environmental attributes could be marked.

Thompson Holidaymaker Report and a recent Mintel Survey (Roe et al. 2002) both found that mainstream tourists want travel experiences more consistent with the SEM model. Examples of SEM within the different sub sectors of recreational tourism follow.

Residential Tourism Sector

The following case study explores the current value of biodiversity and ES to the economy of the Turks and Caicos Islands, and highlights a financing tool for facilitating the maintenance of a model tending toward SEM while threatened with a shift to a BAU model.

Hotel Sector

Movement toward SEM approaches is evident, if partial, in the hotel industry. The International Tourism Partnership, (formerly the

International Hotels Environment Initiative, IHEI) links several major chains including Hilton, Taj, Marriot, Accor, and Intercontinental, comprising over 11,000 hotels and 1.8 million rooms to establish environmental guidelines for the industry and increase awareness. In this way, the hotel industry seeks to self-regulate, influence legislation, and avoid expensive remedial measures. In 1996, IHEI and other industry groups partnered with UNEP to produce the *Environmental Action Pack—Practical Steps to Benefit your Business and the Environment*. This effort has evolved to “Going Green – The International Tourism Partnership’s checklist for minimum standards toward a sustainable hotel” (www.tourismpartnership.org/downloads/Going%20Green.pdf). In 2008, a Spanish version, *El Camino Verde*, was launched (The International Tourism Partnership 2008).

Many hotel chains are setting targets to show commitment to various aspects of sustainability. For example, Fairmont Hotels and Resorts are targeting a 20% reduction (from 2006 levels) in operational CO₂ emissions by 2013; NH Hotels is aiming for a 20% reduction in water, waste, and energy by 2012 (from 2007 levels); and Marriott is reducing its carbon footprint by 25% by 2017 through energy conservation. Whitbread has pledged to reduce carbon emissions 26% by 2020; IHG looks to achieve energy savings of up to 25% across its portfolio of hotels globally; and Starwood has just announced a 30% reduction in energy use and a 20% decrease in water consumption per available room by 2020 (Farrant 2010).

An example of a government initiative to promote SEM within the recreational model is that of Brazil (see Box 9.9).

SEM IN THE CRUISE TOURISM SECTOR

The International Council of Cruise Lines (ICCL) adopted some elements of SEM including mandatory waste management practices, which ended dumping waste at sea. Some cruise lines have begun to mobilize their clients as a source of funding for conservation at destinations (see section on traveler philanthropy below). A variation on this is described in Box 9.10.

SEM NATURE-FOCUSED TOURISM

Nature-focused tourism is a rapidly growing and significant segment of the tourism industry. For example, in 1990, dive and other special interest tourism accounted for 20% or more of all visitors to the Caribbean (Dixon 1993). In South and Central America, major nature-focused destinations have emerged including the protected areas of Costa Rica, Guatemala, Belize, the Galapagos Islands, Brazil’s Pantanal, the Amazon in Peru, Ecuador, Colombia, Brazil, and Bolivia, the fjords of southern Chile, the Atacama desert in northern Chile, Patagonia and the Falkland Islands/Malvinas in Argentina, as well as Antarctica.

Indigenous culture is also driving greater demand for *nature-focused* tourism in countries like Venezuela, Colombia, Ecuador, Peru, and Bolivia where this tourism approach has resulted in the growth of a booming community-based tourism business sector.

Box 9.8. Economic Value of Biodiversity and Ecosystem Services for Productive Sectors in Turks and Caicos Islands³⁸

Part 2 of 2 (SEE BOX 9.3 FOR PART 1)

MOVING FROM BAU TO SEM APPROACHES

In light of increased global focus on issues of natural resource management, biodiversity conservation, and sustainable development, UK development assistance was provided to fund a six-year program of work in the Turks and Caicos Islands (TCI): the Coastal Resources Management Project (CRMP).³⁹

Related to this project, Nautilus Consultants⁴⁰ looked at how best to represent the environmental consequences of actions TCI is undertaking on maintaining an intact and healthy environment. The analysis also showed that future income streams from tourism rely on continuing to achieve a good balance between how and where infrastructure is designed and built, and what the impact of such construction on the environment might be. A good example of this inter-relationship is the role that coral reef systems play in underpinning the quality of life on the islands, but also in securing tourism income.

Valuing the Contribution of Coral Reefs to the TCI Economy.

The assessment estimates that coral reefs contribute to the TCI economy of \$47 million/year. Of this total:

- \$18 million/year feeds directly into GDP, constituting 7.8% of annual GDP for the country;
- a further \$17 million of economic activity (7.5% of GDP) is defended through coastal protection;
- the remaining \$13 million contributes to quality of life through the enjoyment of recreational activities and through existence value, and therefore, is not included in GDP calculations.

To put this into context, analyses carried out by the World Resource Institute Reefs at Risk project estimated that coral reefs across the Caribbean provide goods and services with an annual net economic value in 2000 estimated at between \$3.1 billion and \$4.6 billion derived from fisheries, dive tourism, and shoreline protection services. This estimate for TCI falls into the range of 1% of the all-Caribbean figure, at current prices.

A relatively small reduction in the condition and services provided by reefs could quickly result in annual losses of several tens of millions of dollars to the islands' economy. Viewed one way, it is worth investing several millions of dollars in achieving sustainable ecosystem management to avoid such a situation. Looked at another way, it is not worth taking the risk of sanctioning an environmentally-poor development project for a short-term financial benefit if this is likely to be greatly outweighed by long-term remediation costs — remembering that it is probably not a one very bad development that is likely to cause the bigger problem, but the cumulative impact of a hundred only slightly damaging developments.

In valuing the contribution of biodiversity and other ES in support of the tourism economy, a conceptual framework was devised to relate the values estimated for the various elements to the whole (see Figure).

FISHERIES: A PROVISIONING ECOSYSTEM SERVICE FOR TOURISM

The main commercial fisheries of TCI are spiny lobster and conch. They support an important export industry and supply local restaurants that are service providers for and depend largely on the tourism industry. Identifying revenues earned from fishing the different species and estimating the extent to which each species depends on the reef system, leads to an estimate that the reefs support fishing activity worth \$3.7 million. A significant portion of this activity is driven by tourism.

DIVING: A TOURISM ATTRACTION

TCI is recognised as a top scuba diving location, with over 90,000 dives made yearly. Besides paying for dives, divers also spend money on hotels, restaurants, souvenirs, transport, tours, and so on. In addition, there is considerable consumer surplus for divers (the enjoyment gained beyond the price actually paid for the trip), as described in several economic studies (Cesar et al. 2002). This value is unrealized in monetary terms, though there may be potential to tap it by imposing an entrance fee on dive sites or marine reserves. Overall, TCI's reef systems create of \$8.3 M in diving activity each year.

OTHER TOURISM USES

Reefs are an important component of why people visit the islands as tourists or buy property on the islands. Reefs help to protect

38 The author would like to acknowledge the support of the DIFD UK and the Turks and Caicos Islands Government, and particularly the support from the staff of the Department for the Environment and Coastal Resources (DECR), TCI, most notably Michelle Fulford-Gardiner and Rob Wild.

Research undertaken by Crick Carleton, John Hambrey, and Keith Lawrence; assisted by Marsha Pardee, Kathleen Wood and Lorna Slade.

39 This was funded to the value of \$1.6 million over six years — a sum indicative of the scale of costs involved in moving from a state of Business as Usual to Sustainable Ecosystem Management.

40 A scoping study examining how NR policy and planning could be improved in the Overseas Territories.

- A simple suite of tools to establish the presence and strength of NR management system was tested in the TCI.
- A demonstration of how different types of valuation could be used to better inform decision-making.
- Revalidation of the TCI Protected Area System (PAS) using ecological, economic, and cultural criteria.

Framework for Valuation of Biodiversity and Ecosystem Services



these beaches from erosion ,helping to build them in the first place (the white sand is derived from dead coral). To assess this value we estimated what proportion of visitor motivation to visit TCI can be attributed to the presence of healthy coral reefs. In the short run, the relevant categories here are reef activities (non-diving) and reefs (non-diving). In the long run, reefs also support the country's beaches, so there is a case for including this category. Following this logic, short-run reef values make up 4% of visitor motivation to visit TCI; and in the long run, they support 26% of the motivation to visit. Thus, \$9.8 M of annual spending by tourists to the islands, excluding diving, can be attributed to reefs.

PROPERTY VALUES: SECOND HOME TOURISM

Properties situated on beaches attract much higher prices than those located elsewhere. Take the reefs away and many of the prized attributes of a beachfront location disappear as well.

A portion of the premium of property values is realised through stamp duty on the sale of properties. The rest of the benefits go to the owners of the properties through the ecological services they obtain from ownership each year.

A crude form of hedonic pricing was used to assess the impact that the quality of the neighbouring marine environment has on property prices. Assuming that the effect on property prices extends 100 m back from the coast, property worth over \$2 billion is affected. This amount is converted to an annual flow of benefits using a 10% discount rate and a 25-year period. Following Cesar et al. (2002), it is assumed that 1.5% of the value of property is due to the presence of a healthy marine environment in the vicin-

ity, in the short term. Thus, coral reefs add \$3.9 million a year to the premium paid for seafront properties, in the short term.

COASTAL PROTECTION

The submarine geography of the island chain, combined with the tropical storms that regularly traverse this area of the world, plus periodic heavy swells that originate in the Atlantic, means that these low lying islands are very susceptible to storm damage. The coral reef system can moderate the extent of such damage. A mix of the Expected Damages and the Replacement Cost approaches was used to estimate the value of this protection. The Expected Damages approach assesses the value of property (land and buildings) that is lost or damaged from hurricanes and coastal erosion, and considers how much greater the losses would be if the reefs were not present. In contrast, the Replacement Cost approach looks at the cost of providing an alternative means to achieve the coastal protection afforded by reefs: a human-made coastal defense system. The lower of these two costs was used: for the whole country, coastal protection services provided by reefs is valued at \$17 million/year.

BIODIVERSITY: A TOURISM ATTRACTION

Reefs contain over 25% of all marine fish species, despite occupying less than 1% of the area of the sea floor. Scientists carry out research on reefs to learn more about these ecosystems as well as the ways in which these natural features can be of benefit. This makes reefs a valuable asset for researchers. Studies have shown that many people think it is important that reefs exist, even if they expect never to visit them themselves, and that they are willing to

Box 9.8. (conclusion)

pay to preserve these special places. This perceived value is termed the existence value of the reefs.

Cesar et al. (2003) find that biodiversity in Caribbean reefs is worth \$79 million/year in research and existence value, or \$4,158/km² of coral reef. Applying that value to the 508 km² of barrier reef in TCI, and (conservatively) assuming that patch reef has a biodiversity value of half this magnitude (covering 2,079 km²), biodiversity value totals \$4.7 million/year.

OTHER VALUES

Besides those reef values described above, there are a number of other pathways by which coral reefs might be valued, including the mining of sand, absorption of waste products, “bequest value,” “option value,” and bio-prospecting. These approaches were not tried.

Prepared by Crick Carleton

Box 9.9. Promoting SEM in the Recreational Tourism Sector of Brazil

In an innovative example — a government in LAC making a massive financial commitment to moving the hotel industry away from BAU toward SEM — Brazil’s Ministry of Tourism and Development Bank (BNDES) in February 2010 established a line of credit of 1 billion Brazilian reais (\$545 million) for refurbishing, expanding, and building new hotels.

By offering more favourable conditions to projects that take environmental sustainability into account, the government expects to obtain environmental commitment from the hotel industry. The line of credit was launched in Rio de Janeiro by Minister of Tourism, Luiz Barretto, and Vice President of the BNDES, Armando Mariante.

For the BNDES, the line will enable the hotel industry to adapt to the new reality of the country and to the challenges that Brazil is going to face. “The hotel industry needs to reach a level that will make us proud, one that is able to meet the growing demand,” claimed Mariante.

The line of credit is part of a set of actions of the federal government for the 2014 FIFA World Cup. The line covers the concepts of Standard Hotel, Energy Efficient Hotel and Sustainable Hotel, with different rules for each category.

Source: Travelmole (2010).

Box 9.10. SEM Approach in the Cruise Tourism Sector

The Disney Wildlife Conservation Fund (DWCF) awards grants to non-profit organizations for conservation projects around the world. The fund is supported by corporate donations; Disney Cruise Line guests can also contribute on their gratuity forms at the end of their voyages. Thousands of cruise passengers have done so since the fund was established by the cruise line in 2007. In addition, a portion of the proceeds from the new Disney Cruise Line Castaway Ray’s Stingray Adventure, offered to passengers on Disney’s private island Castaway Cay, goes directly to DWCF. In addition to direct corporate contributions, Disney pays all overhead and administrative costs for the program so that 100% of guest contributions are distributed to non-profit conservation and wildlife organizations. Since 1998, the fund has contributed over \$8.5 million to more than 450 projects around the world.

DWCF supports programs that not only gather scientific information but also engage the community in studying and protecting wildlife and habitats in both marine and terrestrial ecosystems. For example, the fund supports the Archie Carr Center for Sea Turtle Research in developing a sea turtle conservation strategy for the Bahamas, BirdLife International in its efforts to conserve the Bahamas Parrot on New Providence Island, and the Jamaican Iguana Recovery Program, a collaborative effort involving Jamaican and international organizations.

Other programs in cruise destinations supported by DWCF in partnership with local and international NGOs have included the Caribbean Conservation Corporation’s hawksbill and leatherback sea turtle recovery programs at Chiriqui Beach, Panama; coral reef preservation, restoration, and awareness-raising activities by Reef Relief and the Perry Institute for Marine Science in the Bahamas; and the establishment of the Maya Biosphere Reserve’s Environmental Education and Interpretation Center (CEIA) at the ARCAS Rescue Center in Guatemala’s Petén region.

Source: Conservation International (2006).

Nature-focused SEM tourism includes (but is not be limited to) ecotourism, defined by the IUCN as “Environmentally responsible travel and visitation to natural areas, in order to enjoy and appreciate nature (and any accompanying cultural features both past and present) that promote conservation, have a low visitor impact and provide for beneficially active socio-economic involvement of local peoples” (IUCN 1997). Although not attained by most nature-focused tourism, that goal clarifies the key elements of SEM nature-focused tourism.

Cultural and Community-focused SEM Tourism

There has been a marked rise in the demand for a cultural and social dimension to itineraries, especially those of nature-focused itineraries. This has allowed tourist spending to flow to an increasing number of community-based tourism enterprises across the region, which are typically linked to areas with important indices of biodiversity — often close to protected areas. In other cases, revenue generation for communities from this type of tourism has led to their making

concerted efforts to protect biodiversity by creating their own protected areas or making their economic activities more sustainable so as not to undermine the quality of the natural ecosystems that are the main source of attraction for visitors (Wesche and Drumm 1999; Ashley, Roe, and Goodwin 2001). This improves economic benefits for remote communities as well as conserves biodiversity.

A selection of case studies and references to case studies that demonstrate this phenomenon follows.

Box 9.11. The Chalalán Effect and Community-based SEM, Bolivia

Chalalán Ecolodge is a community business⁴¹ offering a wide array of programs and activities for enjoyment and in-depth learning about the rainforest, under the guidance of local indigenous people. The Chalalán company comprises 74 families,⁴² the direct beneficiaries of the company's earnings.

Located inside the Madidi National Park and having a 28-bed capacity, the lodge represents a new community business model that, since inception, has integrated environmental issues into design and operation. Adopting the indigenous building style with use of locally available materials, the hostel has a sewage management system that uses natural processes; also, a large portion of electricity used is generated by solar panels, minimizing the use of fossil fuels. Trails and supporting facilities have been carefully designed, based on studies of the biota in the area; trips are conducted in groups of up to six people, with guides monitoring the status of biodiversity in the area.

The company makes transfers to the community amounting to an annual average of \$20,000, about 55% of its operational expenses. Apart from direct transfers made by Chalalán as donations, contributions, and/or dividends, the community profits from the sale of goods and services to the hostel. Among the main income-generating items for the community are the sale of crafts, supplies, and building materials for the lodge, and services provided to the company, estimated to total \$28,860 annually.

The economic impact of Chalalán's operations in the local region is significant. On average, hotels in Rurrenabaque, the tourist gateway town, receive annually \$30,000; between 2000 and 2006, airlines billed \$650,000 in transfers for guests, and, in the same period, travel agencies earned \$20,000 in commission. Tax contributions are estimated at about \$105,000.

Protection of biota — the company's keystone — have lowered the pressure on the region's forest. This can be noted in the end

to extraction of commercially-valuable tree species (mahogany and cedars) from the area. The high level of conservation achieved in the lodge's sphere of influence is linked to the social-economic impact exerted by the company on the community's population, and to the level of environmental awareness reached by those directly or indirectly benefiting from Chalalán-generated economic flows. This awareness is reflected in actions such as regular monitoring of flora and fauna by local guides. Thanks to such conservation initiatives, reintroduction of such species as the black spider monkey, the white-lipped peccary, and other threatened mammals has been possible.

The community business makes other kinds of contributions. For example, the business played a key role in attaining recognition of community land rights and plays a leading role in economic planning for the territory. Among its other inputs, Chalalán fostered regular water supply in the community, helped construct health posts, granted health loans, facilitated building a school, boosted English language training, and helped implement inter-institutional agreements beneficial to the community. Given the social nature of the company, the community considers that Chalalán enabled improvements in living standards as a whole and, in consequence, many families that had migrated to other places returned. Improvements in health, education, and access to basic services entail significant economic value because they improve the learning and productive capacities of inhabitants and they ease the integration of economic agents into regional and national markets, all under better conditions.

Chalalán's economic success is attributable to three main factors. Availability of *financial capital* helped support the company on the technical and financial fronts, develop adequate local self-management capabilities, and fill several gaps, which limited access to the market. The *social capital* existing in the community helped assimilate a business vision without losing local identity. *Natural capital* was provided by the Madidi National Park, without which Chalalán's business success would not be possible.

Prepared by Alfonso Malky, Conservation Strategy Fund (CSF).

41 Chalalán Sociedad Anónima is a corporation owned by the inhabitants of the San José de Uchupiamonas community, located inside the Madidi National Park; it started to operate in the year 2000.

42 Presently, 100 families live in San José de Uchupiamonas.

Other examples of sem at community level, this time in central america, are described in the following three vignettes, summarized

from larger case studies (see box 9.12). two of the enterprises are led by women.

Box 9.12. Three Vignettes of SEM at the Community Level

AMBAS IN EL SALVADOR¹

In Jujutla, El Salvador, the Women's Community Development Association of Barra de Santiago (AMBAS) is an interesting example of the shift from a BAU to a SEM model of using ES, taking tourism as an integrating, benefit-generating economic activity for the local community.

With the support of UNDP, AMBAS has lead a recovery process for its natural capital and a change in its exploitation of biodiversity resources in the buffer zone of the Barra de Santiago National Protected Area, in which tourism has become the backbone for member livelihoods.

As a result of the process, the mangroves in the area have recovered, the fish and mollusc populations have increased, and livelihoods have diversified, generating economic options and increasing the monthly income of the families involved by \$500/month — all without endangering the quality of ecosystems and biodiversity on which their economic activities depend. Tourism is among the innovations, generating 38% of the total increase in income.

BARRA PARISMINA IN COSTA RICA²

The community association ASTOP took over a program of sea turtle research and protection in the area of Parismina, Costa Rica. These activities have created an inflow of tourists — more

specifically volunteers — that has started to diversify the local economy, in a demonstration of how a community may benefit from conservation of a previously undervalued but charismatic species. This project has proven to be beneficial for many stakeholders. An assessment of the PPD/GEF Costa Rica-funded project reflects the emergence of business opportunities for about 70 families in the community; it has also allowed for the strengthening of ASTOP's research and protection capacity, and for improvement of its technical and financial management capacities.

CHIRA ISLAND IN COSTA RICA³

On Chira Island, Costa Rica, the Ladies' Association is demonstrating that the development of sustainable tourism can energize local communities and create more equitable conditions for women via generation of family income.

Using the natural attractions of the island, the Asociación de Damas de Isla de Chira have created visitor programs and a lodge, La Amistad, from which they develop income-generating opportunities directly and indirectly for about 25 families. These activities have increased earnings by 200% for families directly engaged in the business, and by 30% for those families indirectly involved. This success comes as a result of the strengthening of horizontal linkages in the value chain. The success of the business has led the community to protect a part of the island's forest and the mangroves where they conduct guided tours.

¹ Guzmán 2010

² Calderón 2008

³ Alpizar and Villalta 2008

Niche Markets

One feature in the growth of the nature-focused tourism has been the diversification of products and market segments resulting in development of a range of niche markets, many of which are growing rapidly. Data on economic value, especially over time, is, typically, quite limited. Below is a brief characterization of several of the more economically-significant emerging niche market segments for which some data is available. In general, these niche markets create employment in remote rural and coastal areas and produce higher income multipliers because they rely more on local inputs and less on imports.

Adventure Tourism

Adventure tourism is a broad term to cluster many activities that involve active participation with the outdoors. Although some of the

niche categories mentioned below could also fall under the umbrella of adventure tourism, it is important to look at this growing niche as a whole to better understand its potential impact. In the context of LAC, adventure activities make up a large portion of the diversity of tourism offerings in countries such as Costa Rica, Ecuador, Argentina, and Chile, among others. The Adventure Travel Development Index (ATDI) offers a ranking of countries based on principles of sustainable adventure tourism. The index seeks to gauge the potential of a country to host an adventure travel market. Some of the criteria used in the ATDI to gauge a country's potential are directly related to the state of the natural environment, with indices that measure a destination's natural resources, sustainable development, image, and adventure resources. Unfortunately, many countries in the LAC region scored relatively low in the ATDI, in part, due to image concerns related to the natural environment as well

as poor natural resources management. Of countries in the LAC region, only Chile ranked in the top 10 countries this year (Adventure Travel Development Index). This reinforces one of the principal conclusions of this paper: current growth and long-term potential of tourism in LAC is undermined by a lack of understanding of the contribution of healthy biodiversity and ES to the sector.

It is widely recognized that the adventure market is a large and growing tourism arena, an emergent portion of the niche tourism market. With favored activities such as mountain climbing, rafting, trekking, etc., quality natural resources are an essential requirement for a destination seeking to exploit this market. Few studies exist to quantify the size and scope of this evolving sector. New research has begun to emerge; a recent study by the Adventure Travel Trade Association, Xola Consulting, and George Washington University focused on three major tourism generating markets: Europe, North America, and Latin America, estimated to represent 70% of international tourism departures. The study found that the adventure market, including soft and hard adventure, represents approximately US\$52 B/year in spending, excluding the costs of gear, on a global level. Participants in soft adventure trips were likely to spend \$250 more per trip than tourists participating in other, more traditional tourism activities (George Washington University, Adventure Travel Trade Association & Xola Consulting 2010).

Bird Watching

Bird watching is probably the largest segment of nature-focused tourism motivated by wildlife, with large numbers of European and North American tourists travelling to the tropics to see birds as their main or a major reason to travel to a destination. On a global level, one study found that bird-related tourism attracted as many as 78 million travelers with economic impacts as high as \$78 billion for the economies of the countries they visited (Filion et al. 1992). In North America, bird watching continues to gain popularity. While most birdwatchers are considered “backyard” birders, in the US, from 2001 to 2006 there was an 8% increase in individuals who traveled to observe birds (US Fish and Wildlife Service 2009).

Although this is a large, fast-growing niche, remarkably little economic data is available on bird watching. Several country-specific studies offer a glimpse at the economic impact that bird-related tourism may have. The US Fish & Wildlife Service estimates that approximately \$12 billion was spent by American tourists on bird watching trip-related expenses in 2006, with 57% of this allocated to food and lodging, 35% to transportation, and 7% to other costs like guides and user fees. The same group is estimated to spend over \$24 billion on equipment expenses, mostly prior to travel. Bird watching also had a very positive impact on employment and tax revenue (US Fish and Wildlife Service 2009). A study on Costa Rica’s Monteverde Cloud Forest reserve showed \$18 million in direct spending in 2006, solely by people visiting to see one of two charismatic species:

the resplendent quetzal and the bell bird. This represented 28% of all tourism spending at that destination (Allen, Lines, and Hamilton 2008).

Scuba Diving

Like bird watching, scuba diving is a huge market segment that depends overwhelmingly on healthy biodiversity, in this case, coral reefs. The number of dive certifications issued by PADI, which certifies over half of all divers globally, is now over a million people per year and over 10 million in total. Growth of Caribbean dive tourism will continue, but the level achieved by 2015 could be lowered 2%-5% as a result of coral reef degradation, costing the region about \$100 million-\$300 million annually (Agard and Cropper 2007).

An estimated 15 million dives take place outside of Florida each year, half of these occurring inside marine protected areas (MPAs). Only 25% of MPAs containing coral reefs charge divers an entry or fee, which is most usually \$2-\$3 levied per dive or per diver (Green and Donnelly 2003). The revenue generated by these fees is estimated at \$1 million-\$2 million annually, but the potential for income generation has not been fully realized. A significant part of the cost of regional reef conservation could be covered if fees were applied more widely than at present.

Whale Watching

Whale watching has increased dramatically as a nature-focused tourism activity. In 1998 whale watching occurred in 492 communities in 87 countries. More than 9 million tourists spent over \$300 million in direct expenditures and over \$1 billion in all. Whale watcher numbers grew during the 1990s by an average of 12% annually and spending by 18% (Hoyt and Hvenegaard 2002). Baja California (\$5 million+), the Dominican Republic (\$5.2 million), the Bahamas (\$3 million), and Dominica (\$1 million) have the largest whale watching operations in LAC.

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Sport Fishing

This is an extremely important niche market in terms of size, value, and impacts on both freshwater and marine ecosystems. Currently, much of this activity cannot be considered SEM, though there is increasing interest in catch and release practices, which, potentially, could give rise to a more sustainable fishing model.

The value of recreational fishing in Pantanal (Brazil) was assessed using the Travel Cost Method to estimate the consumer surplus of current recreational fishers; the values range from \$541 to \$870 per trip, resulting in a total social welfare estimate range of \$35 million to \$56 million. The study demonstrated the relatively high value

of recreational fishing in the Pantanal (Shrestha et al. 2002). Recreational fishing is already an important economic activity in the region's many rivers and an alternative income generation mechanism which currently competes with commercial and subsistence fishing. Although only part of the overall value of the resources and ES within the Pantanal, the value of recreational fishing provides a growing alternative, non-consumptive activity (through ecotourism and catch and release fishing) and a price premium not seen in the commercial fishing sector. Management strategies need to attract more nature-based tourists,

allowing local people to capture these benefits.

A comparison of sport fishing between the Bahamas and Belize showed that this is a very significant niche market in economic terms, damaged under BAU practices, but positively susceptible to SEM approaches. The total economic benefit of flats fishing in the Bahamas nears \$141 million annually (The Bahamian Flats Fishing Alliance 2010). Without effective regulations in place, there is concern for the ability of Bahamian fisheries to maintain the ES to ensure sustainable catch rates. Catches have fallen by 75% from 20 fish/day to 5-6/day. The large resorts, fishing lodges and other facilities are clustered in one area, which dramatically increases pressure on the resources of nearby fisheries. Concern is growing within the Bahamas regarding the negative impact on water quality of waste disposal and runoff, as well as about fisheries habitat destruction from development and resort construction that cleared dozens of acres of mangrove and filled wetlands. Worse, some ventures then closed, leaving the area partially to fully undeveloped, with erosion problems and habitat degradation for others to contend with.

A SIGNIFICANT PART OF THE COST OF REGIONAL REEF CONSERVATION COULD BE COVERED IF FEES WERE APPLIED MORE WIDELY THAN AT PRESENT.

Box 9.13. A Turtle Tourism Case Study, with Focus on Brazil and Mexico

Throughout the tropical and sub-tropical areas of LAC, turtle ecotourism projects have grown in recent years as tourists seek a hands-on experience with turtle conservation. A recent study looked at the impact of turtle conservation projects in Mexico and Brazil. Seeing that turtles get the ES they require turned out to be a means of meeting the needs of these rural populations as well.

The Table below compares social indicators in the two towns, Mazunte and Praia do Forte, before and after the turtle projects. Before, households had virtually no potable water or electricity, nor access to health facilities and schools. The turtle projects significantly improved household welfare. Average family income increased by 17% in Mazunte and more than doubled in Praia do Forte. Universal access to piped water was achieved in Mazunte, with 95% coverage in Praia do Forte. A hospital was opened there and a clinic in Mazunte. Three schools were opened in each town. Food and nutrition also improved.

The value of rentable spaces and land plots increased significantly. For example, a commercial space of 60m² in Praia do Forte could be rented for about \$600 in 1999, whereas by 2007 the same space would cost \$3,000. In Mazunte, a 2,000m² plot of land would sell for about \$4,000 in 1999, while by 2008 a land lot of the same size would sell for about \$21,000. Community members have integrated themselves into ecotourism by offering lodging, dining, and entertainment. Before the turtle projects, both towns were isolated and relied on turtle hunting and cultivation of one or two crops. The experience of these towns shows that well-designed local ecotourism initiatives can reduce poverty. Fishing is less profitable now, but it no longer threatens sea turtles and still guarantees additional income and food. Through training and capacity-building, local communities were able to move from basic subsistence to a successful, service-oriented economy.

Changes in Key Social and Economic Indicators as a result of Turtle Tourism

Mazunte, Mexico (population, 2,000)					
	Family Income	Piped water	Electricity	Health	Schools
Before conservation (1999)	US\$600	0 homes	0 homes	0	0
After conservation (2008)	US\$700	1,000 homes (100%)	1,000 homes (100%)	1 clinic	3 (K-12)
Praia do Forte, Brazil (population, 5,600)					
	Family Income	Piped water & sewage	Electricity	Health	Schools
Before conservation (1999)	US\$300	0 homes	0 homes	0	0
After conservation (2007)	US\$900	1,900 homes (95%)	2,000 homes (100%)	1 hospital	3 (K-12)

Source: Data collected by author; and Comisión Federal de Electricidad (CFE) and Department of the Municipality of Santa Maria Tonameca, for Mazunte; and Companhia de Eletricidade da Bahia (Coelba) and Empresa de Agua e Saneamento da Bahia (Embasa), for Praia do Forte.

Source: Fleischer (2009).

In Belize, flats fishing is worth \$56 million annually to the Belizean economy. Where there is good awareness of the relationship between biodiversity health and tourism revenue, a catch and release policy has been implemented for sport fishing so that each bonefish, permit, or tarpon caught must be released back into its natural habitat (Fedler 2008). With the catch and release policy in place, it is anticipated that these high value sport fisheries will be fully sustainable (Mason 2010).

responds to the market’s growing interest in the cultural exchange dimension of the vacation experience and puts greater value on human resources in tourism service provision (Adams 2009). It is unclear how much significance should be attached to the accumulation of these types of refinements in the basic mass recreational model in terms of transformation from BAU to SEM, but the gap is narrowing.

9.7 COSTS OF TRANSITION FROM BAU TO SEM

Little data is available on the financial costs of transition from BAU to SEM; obviously, the cost differs greatly in accordance with the situation. However, where the transition offers a reduction of operational costs or a more competitive stance at no extra cost, many elements of the SEM model are being incorporated into the traditional recreational BAU tourism model.

INCREMENTAL AND COST-EFFECTIVE CHANGE

For example, hotel chains now routinely encourage guests to re-use towels and sheets for multiple days as a way of reducing water and detergent consumption, and wastewater volume (while reducing costs). Low energy lighting is increasingly common in large hotels. Airlines are incorporating more fuel efficient aircraft. Cruise ships have adopted standards to control dumping of waste near coral reefs. On the cultural front, the world’s largest cruise ship — Royal Caribbean’s recently launched Oasis of the Sea, which carries 6300 passengers and 2165 crew — has the service staff introduce themselves by name and country of origin in an effort to distinguish their product, which

NATURE-FOCUSED TOURISM EXAMPLES’

Studies in Ecuador (Rodriguez et al. 2008) and Peru (Leon et al. 2009) show that tourism is by far the largest source of self-generated funds for these countries’ park systems, even though they capture only a small part of potential tourism revenues. While countries in the region have a comparative advantage in the growing nature-focused tourism sector, it is also clear that this growing sector needs to be well-managed (Drumm and Moore 2005). If that can be done, both international and domestic tourists have shown a willingness to pay more for SEM nature-focused tourism than the fees currently charged (Figure 9.6) (Rodriguez et al. 2009; Leon et al. 2009). High interest from consumers for a transition from recreational BAU to SEM also exists: two large European travel agencies recently moved to launch a new brand of sustainable tourism products after carrying out customer research that found that 96% of holidaymakers care about protecting the local environment and wildlife in the resorts they visit and 83% want advice on greener holidays from their tour operator (Travelmole 2010).

Self-financing Nature Centers

Adjusting revenue generation mechanisms to capture this income that is currently being lost is essential to pay for the transition costs from nature-focused BAU to SEM in protected areas. These costs have been identified in studies of both Ecuador and Peru; they include five core elements of visitor management capacity that are typically lacking in protected areas throughout the LAC region.

Figure 9.6. Example of Visitor Price Responsiveness to Increased Entry Fees at a Peruvian Protected Area

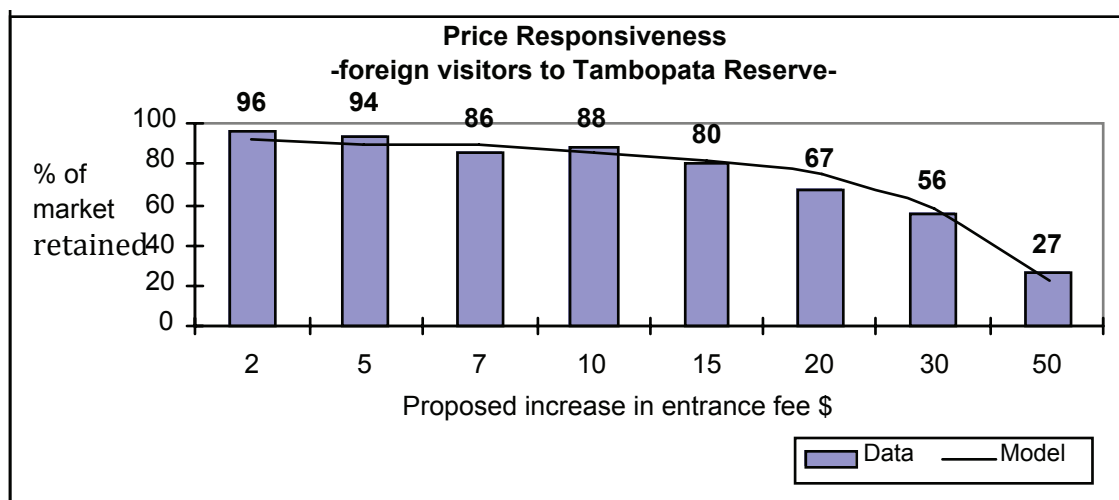


Figure 9.6 suggests that visitors are disposed to support the cost of such a transition. For instance, the information shows that 80% of foreign tourists would be willing to pay \$15 more for entry to the Tambopata Reserve (there is a range of fee levels, but that would about double the current average amount charged). This visitor price responsiveness is repeated in several protected areas in Ecuador and Peru, and would likely be similar for most park systems in LAC, suggesting the scale of additional revenue that could be generated to support transformation of management of the reserve to SEM.

These investments are often highly cost-effective. For example, the Eduardo Avaroa Reserve, high in the Andes, is the most visited protected area in Bolivia, receiving over 80,000 foreign visitors in 2009. Introducing a basic tourism management capacity here that would move the protected area from BAU to SEM — including capacity to register visitors, charge fees, and provide basic protection, interpretation, and infrastructure — had an estimated annual cost of only \$105,000. In contrast, the introduction of an income generating mechanism, an entrance fee in this case, now mobilizes over \$250,000 in revenue annually.

In 1992, by implementing a \$10 user fee in the form of an annual scuba diving tag, Bonaire National Marine Park became the first fully self-funded marine protected area in the Caribbean. These reefs continue to be among the healthiest in the region, despite receiving 38,000 visitors annually, because revenues generated from tourism are more than sufficient to cover the costs of SEM practices (STI-NAPA; Parsons and Thur 2008).

Given the current and projected growth for SEM nature-focused tourism, LAC protected areas are in an excellent position to increase revenues and finance the cost of moving from BAU to SEM from the higher revenues, while at the same time, increasing their attractiveness to the market.

RECREATIONAL TOURISM EXAMPLES

The data referenced above indicate that the mainstream of the recreational tourism industry has begun to take steps to address the need to move from BAU to SEM. At this point, the majority of these transition steps both lessen negative environmental impacts and reduce operating costs, thereby increasing profitability. IHG — the world's largest hotel chain — reports saving \$50 million as a result of its Green Engage scheme and estimates it could generate \$200 million in savings across its 4,000 hotels (IHG 2009).

To move fully to SEM practices would require a greater but far from unfeasible effort. In a recreational tourism context, studies by Rainforest Alliance estimate the investment cost for hotels for implementing best practices to be about 1%-3% of operating costs (see Box 9.14). Certification programs permit this investment to be used as a marketing advantage and are the main means of making the transition.

Box 9.14. Benefits and Costs of SEM as Defined by Certification

A study by Rainforest Alliance showed that among 14 hotels in Costa Rica, Nicaragua, Belize, Guatemala and Ecuador, 71% reduced their operating costs and improved profits as a result of certification. They did this via several routes. All reduced water consumption, saving an average of \$2700 annually. Almost all lowered energy consumption even though several hotels expanded operations; annual savings averaged \$5,300. Reductions in the production of solid waste through reusing materials lead to annual savings of around \$3,600.

Almost all hotels stated that their support for biodiversity conservation made their hotel more attractive in the market and improved their competitiveness. The cost to hotels to achieve certification was 1%-3% of operating costs.

Certification

A growing segment of SEM in recreational as well as nature-focused tourism consists of enterprises that have sought and achieved certification of sustainability and use of best practices. Eco-labels are a voluntary mechanism for private businesses to show responsibility for the environment. They can also serve to encourage tourism businesses to comply fully with existing legislation. More than 100 eco-labeling and certification programs offer logos, seals of approval, or awards designed to show environmentally superior tourism practices (World Tourism Organization 2002).

Currently, the penetration of eco-certification in the region is weak: less than 1% of tourism businesses participate in certification schemes. Yet, in places that have made a commitment to sustainability in tourism, participation is greater. For example, in 2008, in Costa Rica, 161 of 2,595 hotels and lodges (6.2%) were certified or had begun implementing best practices. Growth in the number of certified businesses is high, doubling in Costa Rica between 2005 and 2009 with an average of 20 newly certified businesses annually. In Ecuador, in 2008, of a total of 3,213 hotels and lodges, 95 (3%) participated in these programs; similarly, in Guatemala, 63 of 2,574 hostels (2.5%) were part of sustainable tourism initiatives (Rainforest Alliance 2010). Additionally, Green Globe 21, a leading certifier of recreational tourism, has certified 122 hotels and two destinations in the region as of 2009, with Mexico, Jamaica, and Barbados leading in numbers of certified hotels. This trend bodes well for reaching a critical mass, whereby the market, governments, and the industry will reach a tipping point with regard to ensuring a competitive stance and improving the industry's environmental footprint.

There is ample evidence that adopting environmentally friendly measures can both save significant amounts of money for hotel chains, as well as increase market profile and demand. Scandic Hotels, with 158 hotels in Europe is a leading example of a chain that has transitioned successfully from BAU to SEM, saving over 18 M Euros by adopting more efficient use of energy, water, and waste (Scandic Hotels 2010). Kimpton Hotels in the US estimates 18% of its clients choose to stay with them because of their commitment to SEM (Kimpton Hotels 2010) The LAC region is lagging in developing hotel options that appeal to this growing market segment.

It remains to be seen to what degree the industry will continue to invest in moving BAU operations to SEM beyond internal cost-saving measures and to what extent such investments may satisfy the emerging demand for greater sustainability, thereby leading to a rejuvenation phase as described in Figures 3 and 4 that will increase per visitor profits. The recreational model relies on high volume/low margin profit, so the BAU to SEM by Rejuvenation option needs to address improving existing infrastructure and operations but maintain a competitive advantage vs. new enterprises that pursue SEM by Design. The new schemes for the hotel industry discussed above are beginning to address the former, but a greater paradigm shift will be required to address the latter. If market sensibilities continue to reflect this current trend, which is likely, then industry giants may need to move quickly to maintain their historic success.

9.8 ECONOMIC NET BENEFITS OF SEM

Over the long-term, sustainable, nature-based tourism has the potential to provide unique experiences and interactions with nature and local societies that, in turn, nurture an even greater appreciation for biodiversity conservation and cultural preservation. The SEM approach can generate much-needed financial resources for furthering conservation efforts, as well as economic benefits for local people. The classic indicator country for the emerging demand for nature-focused SEM is Costa Rica. International arrivals in Costa Rica doubled in 1992 after the country introduced a new marketing program promoting itself as an ecotourism destination (ILMB of Canada) By 1996, 66% of all tourists reported visiting a protected area during their stay.

For the higher volume recreational model that predominates in most of LAC, the hotel chains, airlines, and cruise lines have a much greater influence on legislation in destination countries. If destination country governments can more effectively anticipate the market demand for greater sustainability, they can better structure their tourism development plans to that end. More rigorous environmental impact assess-

ments, greater capacity-building for government officials, and greater coordination between public agencies, with the local private sector, and among destinations can better prepare a destination to engage productively with the industry and hasten the transition from BAU to SEM. Countries, destinations, and firms that lag may lose competitive ground in the context of shifting market preferences.

To countries, SEM offers a range of economic benefits including improved income multipliers, opportunities for new tax revenues, foreign investment, and improved equity for rural and coastal communities.

Tourism Income Multipliers⁴³

One powerful indicator of the benefits of SEM are Tourism Income Multipliers (TIM). This indicator expresses the total additional income accruing to people in the destination for each unit of additional tourist spending. The TIM is high when an additional tourist dollar stimulates production on many levels within the local economy (e.g., purchase of a meal creates demand along a well-developed supply chain: waiters, cooks, grocers, truckers, farmers, agricultural input producers, manufacturers of tractors, trucks, and cooking implements, steel mills, mines, etc. as well as food, housing, education, health services, and other inputs to the work forces at each level). The TIM is low when the tourist demand is satisfied by imports from outside economies. These multipliers tend to be higher for SEM tourism than for BAU. SEM tourists tend to consume more local products and services as these characterize SEM products and distinguish them from BAU, for example, community-based tourism which overlaps closely with SEM, also tends to have a high TIM (Drumm 1990).

An interesting example is that of Dominica, initially with a high tourism multiplier for a Caribbean destination, estimated at 2.1 for 1990 (Weaver 1991). By 2000, leakage from the Dominican economy had increased markedly and the multiplier effect diminished accordingly, falling to 1.45. The primary reason for the leakage was more profits going abroad (either a significant increase in foreign ownership of tourist facilities, with owners repatriating profits, or local owners investing their profits abroad) (Cater 1996). This decline in income multiplier appears to coincide also with a transition from a nature-focused SEM model toward a more mass-recreational BAU model of tourism as the country sought higher numbers of visitors. This is ironic because Dominica was hailed as a pioneer of SEM and ecotourism in the early 1990s. In contrast, countries like the Dominican Republic, which gambled on the traditional recreational BAU model, are only now taking tentative moves toward diversifying their tourism economy by investigating SEM and nature-focused tourism.

Another example is demonstrated by a study of tourism's impact around Costa Rican protected areas. This research found that

⁴³ Although a valuable tool for comparative economic analysis, few recent TIM studies were found in researching this paper.

tourism around Poas National Park has a multiplier estimated at 1.65 – similar to more developed economies, illustrating a high degree of integration of the local economy and quite limited economic leakages (Aguirre 2008). Income multipliers for BAU recreational tourism in the Caribbean range between 0.65 (Cayman Islands), 0.78 (the Bahamas) and 0.88 (Eastern Caribbean) (Meyer 2006).

Furthermore, SEM tourism multipliers tend to be higher than alternative economic activities within a country. For example, the Bolivian Ministry of Planning and Development (2001), found that every dollar spent on cultural and nature tourism in Bolivia generates another \$1.2 in indirect benefits (Fleck 2006). This was the highest economic multiplier among a list that includes mining, oil and gas extraction, agro-biodiversity and forestry, and hunting and fishing. The high multiplier of cultural and nature tourism in Bolivia may be a result of the sector being relatively human resource-intensive, labor being one of the main inputs to produce many of the services delivered to tourists.

In Costa Rica, an estimated 44% of tourist spending stays in the local economy; 56% leaves (the part that stays may build a higher TIM if spending is recycled internally many times) (von Moltke 2000). This contrasts with the Caribbean model of large-scale recreational tourism where economic leakage is even higher. In the Dominican Republic, it is estimated that as much as 80% of the income generated by all-service package hotels leaves the national economy (Lopez 2007).

Return On Investment

Studies show that biodiversity and unspoiled nature allows investment in ecotourism to have one of the highest returns on investment (ROI) of all the different type of tourism products available (Christ et al. 2004). Ecotourists tend to pay more per day and take longer trips than recreational tourists, thus expending more money per visit. These ecotourists also use fewer resources, including energy, fresh water, and creature comforts like air conditioning, than do recreational BAU tourists, thus requiring less investment from tour operators and hotels. The downside is the issue of scale. SEM nature-focused tourists prefer smaller hotels, which permit a more intimate experience with the natural environment than large ones with a larger footprint. Thus, ecotourists spend more per person, but on a more limited overall scale.

Meanwhile, the large hotel sector is making significant cost savings and improving ROI by adopting SEM-type resource management measures, as discussed above.

Tax Revenues

In addition to the entry and use fees generated by protected area systems, tourists and the tourism industry are an important source of

tax revenues. However, with recreational BAU tourism models, the dominance of large transnational corporations leads to downward pressure on taxes in destination countries by provoking competition among these counties to attract investment by lowering taxes. Cruise lines and hotel chains, for example, have benefitted.

The longer-stay profile of nature-focused SEM tourists leads to higher spending and payment of more taxes, as well as greater sales taxes gains as a result of the consumption of local inputs and products that characterize SEM.

Airport departure taxes are quite common, but Belize, which has positioned itself as a nature-focused destination, has a departure tax that is used directly to fund biodiversity conservation. The Protected Areas Conservation Trust in Belize is a fund dedicated to the promotion, sustainable management and development of Belize's protected areas, with a longer-term view to improve the quality of life of Belizean citizens. Established in 1995, the fund is primarily financed from the collection of a conservation fee: \$3.75 is paid by visitors upon departure from Belize. A 20% commission is also collected from the cruise ship passenger's head tax, and from all recreation-related license fees and concession fees on protected areas (PACT 2006). Such biodiversity-targeted taxes are still rare, but are good examples that appeal to the increasing number of environmentally-conscious travelers.

Foreign Investment

There are signs of growing interest of foreign investment in SEM tourism around the LAC region with the creation of funds such as the EcoEnterprises Fund, Verde Ventures, and Conservation Capital, which have channeled both private and public funding into SEM tourism across the region. Private tourism companies have also begun to vertically integrate the nature-focused SEM value chain by purchasing in-bound tour operations in LAC.

Improved Equity

As seen early in this chapter, BAU tourism tends to limit equity by principally creating low-paying jobs that tend to benefit one sex more than the other (usually men more than women). There are many good examples of SEM producing a much better distribution of benefits. For example, a study of the community benefits from tourism at five protected areas in Ecuador reported tourism as the primary economic activity in over 10% of all households, with this activity contributing an average monthly income of \$28 across all households or 13%. At one site, tourism constituted as much as 47% of average monthly income. Responses from "families with ties to tourism" found that 19% of them considered their quality of life "very good" compared with only 3% of "families without ties to tourism" (Rodriguez 2007).

One study (Wunder 1999) analyzed the alleged participation-income-conservation link in the Cuyabeno Wildlife Reserve in the

Ecuadorian Amazon. Tourism income earned by five local communities ranged from \$15,000 to \$50,000 annually. Ecotourism operating within the reserve represented a significant increase of income for local communities (about \$100 to \$500/person/year. Both the employment and community involvement advantages created incentives to reduce exploitation and create “untouchable” reserves.

Emergence of a tourism operation in rural areas can provide women, often among the poorer members of society, with a means to increase welfare, security, and empowerment. Employment of women also tends to contribute more to social and economic development than employment of men alone. In Bunaken, Indonesia, and Apo Island, Philippines, dive tourism associated with marine protected areas created more high-income job opportunities for women, with residents noting an improvement in women’s lives (Leisher 2008). Within Costa Rica’s Tortuguero National Park, women made up 20% of local guides, an activity still dominated by men (Troëng and Drews 2004).

Brazil’s marine turtle conservation program (Projeto TAMAR) was founded in 1980; the program distributes tourism revenue to both women and communities that do not have direct access to tourism but whose conservation efforts are also important for the long-term survival of the key species. At locations with little or no tourism, productive groups have been encouraged to manufacture turtle themed goods for sale in Projeto TAMAR’s visitor centers. Sixty percent of employees are women (Troëng and Drews 2004).

These examples suggest that SEM nature-focused tourism businesses may have been relatively successful in strengthening the distribution of benefits to poorer strata of society and in benefit of women too.

Traveler Philanthropy

One of the defining characteristics of SEM tourism is the visitor commitment to responsible behavior and to contributing to biodiversity conservation. The concept of traveler philanthropy has grown rapidly in recent years, mirroring the growth of SEM nature-focused tourism. The Disney Cruise line is described in a case above; another company in the Galapagos Islands has generated \$4 million for conservation from their clients in the past decade. The global value of traveler philanthropy is currently estimated at about \$100 million annually. In Africa, this voluntary giving tends to be channeled toward poverty alleviation and community projects, while in LAC, the philanthropic impulse tends to flow to biodiversity conservation (Honey 2010).

Perhaps, because much if not all of the money raised comes from clients and not from the businesses themselves, this has been an area where many large recreational tourism chains have seen an opportunity to respond to market demand for more sustainability; this is

an element where recreational BAU is taking positive steps toward SEM. Many nature-focused businesses support local conservation groups with ‘in kind’ donations and also by facilitating donations from clients and, in some cases, making cash donations from profits. This is a concept that has the potential to generate considerably more funding for biodiversity conservation by engaging the mainstream of the recreational and nature-focused tourism industry to join with the current industry leaders.

PART III: CONCLUSIONS AND RECOMMENDATIONS

9.9 CONCLUSIONS

The tourism sector, including the conventional recreational sun and sand category and the burgeoning nature-focused types, is largely dependent on healthy biodiversity and maintenance of ES. This dependence is manifested by the provision of clean beaches, healthy reefs, fresh water, birdlife, fish, whales, forests, and the other attractions and facilities that drive demand.

The growth rates in arrivals of SEM tourists appear to be greater for LAC than those for BAU models, as is spending per visitor for SEM-oriented tourism. However, BAU continues to drive the dominant tourism model in the region in terms of volume of visitors and total revenues, though not in per capita spending. This is the case because BAU mass tourism models deliver very significant short-term profits to the private businesses involved, typically foreign transnationals in the case of high-volume recreational tourism. However, these high, short-term private profits come at the price of increasingly visible public costs to ES, biodiversity, and equity.

Indeed, one of the principal conclusions of this paper is that the current growth and long-term potential of tourism in LAC is undermined by a lack of understanding by policy makers of the contribution of biodiversity and ecosystem health to the tourism sector.

As natural capital continues to be eroded by BAU tourism, segments of key markets, investors, and the media are increasingly seeking alternative SEM tourism opportunities. Those countries sensitive to this transition have benefitted significantly, like Costa Rica and Ecuador. Others — such as Panama, Peru, and Bolivia — are taking steps to implement policies that will facilitate the BAU-SEM transition. Even countries that have been fully committed to the BAU model of mass tourism (e.g., the Dominican Republic and Cuba) are taking steps to diversify their tourism product to include SEM options.

There is an enormous opportunity cost for both the public and private sectors in maintaining the BAU model. The huge environmental footprint and the erosion of natural capital under BAU practices are actively undermining the potential of destination countries to benefit from tourism of either sort in the future. Indeed, many BAU destinations are already in decline. Galapagos has been added to UNESCO's 'World Heritage in Danger' list in part because of uncontrolled tourism. Acapulco, once a top destination for big spenders, now struggles to generate international tourism business; the BAU model there has led to heavy pollution of the bay and severe social problems such as prostitution and drug-related violence. Similar results of the short term BAU approach have been discussed in examples including Roatan in Honduras, the Dominican Republic, and Cancun. These destinations face collapse with huge losses for the tourism sector unless a SEM rejuvenation can take place or aspects of SEM by design are introduced in the near future. The large transnational entities that dominate marketing and destination-making are not tied to any particular sites but are free to switch their sights to fresher targets.

The initial costs of converting from BAU to SEM in the mass, recreational sector are likely high, though this has not prevented dramatic initiatives in Mallorca, Spain, for example. However, small steps are feasible and can even produce short-term economic benefits, for example, by reduction of freshwater use, improved waste management, and lowered energy consumption in large hotels.

SEM models are currently in high demand in the European and North American markets. It is widely predicted that growing demand for SEM tourism options will continue to outstrip that for BAU for the foreseeable future. This market demand will provide significant SEM-oriented business development opportunities throughout the LAC region. There are big opportunities for recreational tourism entities including hotels and cruise lines to partner with SEM nature-focused excursions in the Caribbean and Mexico, and for urban hotels in large tourism destinations like Rio de Janeiro and Cartagena.

The long-term competitiveness of nature-based tourism products and services is tightly linked with the health of the natural systems on which they are based. When tourism is pursued through unsustainable operations that result in degradation of the surrounding ecosystem and/or social systems, it compromises long-term economic returns to the sector and to the destination countries.

The tourism sector at the international institutional level and at the level of small businesses, especially in the nature-focused segment, is increasingly conscious of and concerned about fostering SEM. However, these entities represent a small percentage of current demand. The large businesses at national and international levels, and their national government counterparts are still, by and large, committed to BAU, even when making statements supportive of SEM.

Part of the reason for this lag in transition from BAU to SEM is a result of the fact that tourists, even those very supportive of SEM, tend to be tolerant of deteriorating biodiversity and ecosystem conditions because most visit a place only once and, therefore, lack a historical perspective on its condition. They have no idea whether its natural attractions and the quality of the experience may have declined over time. Destructive tendencies may be well advanced by the time conditions have declined to a point that first-time visitors react. This elasticity of demand in the face of the erosion of natural capital by BAU tourism means that the industry can delay responding and policy makers may not become aware of the decline until remedial action becomes either very expensive or simply too late.

From personal experience visiting the Galapagos Islands in each of the past 25 years, many return visitors confirm that congestion on trails and at anchorages has risen dramatically, with palpable impacts on vegetation and wildlife species. Yet, new visitors have no sense of what they are missing. It is critical that systems to monitor tourism impact be set up to measure change and facilitate informed management decisions. Without these monitoring systems, there will be little means to protect the biodiversity and ES that underlie the attractions and drive demand.

Given the current and projected growth of SEM nature-focused tourism, LAC protected areas are well positioned to increase fees and finance the cost of moving from BAU to SEM from the higher revenues, while, at the same time, increasing their attractiveness to the market.

Equity improvements are associated with the rise of nature-focused tourism, especially SEM nature focused tourism since remote, poor rural and coastal communities tend to have better biodiversity, ecosystem health, and socio-cultural features that add to the attraction. Women, often in these locales, are more active and benefit more than usual in nature-focused SEM.

Traveler philanthropy has emerged as a component of SEM that is attractive to the large-scale international recreational BAU companies as well as to the nature-focused sector. Great opportunities exist to extend traveler philanthropy beyond sector leaders into mainstream tourism.

Certification of tour operations for best practices and sustainability has played a small role so far, but demand is growing. Award programs have grown in number, size, and prestige with major organizations such as the World Travel and Tourism Council and National Geographic launching high-visibility award programs. These certification programs are likely to continue to grow and to play a larger role in signaling the SEM merits of particular destinations or products to visitors planning their trips. The sources of information, especially websites, which promote responsible tourism and SEM models have proliferated considerably over the past decade.

SEM brings a range of economic benefits including improved income multipliers, opportunities for new tax revenues, foreign investment, and improved equity for rural and coastal communities.

Niche markets that focus on and, indeed, depend on biodiversity health such as whale and bird watching, wilderness hiking, diving, and other natural resources are large and rapidly growing. Tourists in these market segments also tend to spend considerably more per person than BAU tourists. These green tourists represent significant revenue and employment across the whole region. However, the inextricable linkage between these products and healthy biodiversity and ES make these niche market locations vulnerable to ecosystem deterioration. This degradation is caused in large part, particularly in coastal regions, by BAU tourism.

There is a notable absence of data on the value of SEM tourism and the costs of BAU, or more broadly, on the comparative costs and benefits of these tourism models. If information were more readily available it is likely that it would serve as further catalyst for opportunity transition from BAU to SEM tourism.

9.10 RECOMMENDATIONS

PRIVATE SECTOR

Ensure fulfillment of both environmental and social values in regulations and best practices.

Actively engage with local communities in the design, construction, and operational phases of developments.

Develop strategic alliances and business partnerships among coastal and urban recreational businesses and nature-focused SEM.

Design resource-efficient hotels and infrastructure, by establishing objectives for reducing environmental footprints.

Follow the example of industry leaders to institute traveler philanthropy programs where opportunities for the clients to donate to local biodiversity conservation at the destination are facilitated.

It is critical, however, that such voluntary mechanisms be a complement to and not an alternative to proper licensing, permitting, and concession fees paid by businesses to government authorities to ensure the maintenance of consistent and adequate tourism management funding within Ministries of Environment and Tourism.

Improve collaboration with national parks systems to ensure that adequate impact monitoring takes place and that appropriate management measures are active to prevent congestion, overuse, and related impacts on ecosystems, as well as to collect entrance fees, concession values, and permits charged by protected areas.

PUBLIC SECTOR POLICY

Promote awareness of the critical role of biodiversity and ES in maintaining and enlarging tourism's contribution to economic development.

Ensure national policy is aligned with international protocols to which they are signatories through UNWTO and others.

Build capacity to develop SEM including training programs for public, private, and community sectors to both build a domestic SEM tourism sector and better control foreign investment.

Develop Strategic National Tourism Plans, with multi-stakeholder involvement, which integrate recreational and nature-focused sectors into a holistic vision for development.

Involve stakeholders and implement effective land-use planning, especially in coastal regions and areas around national parks, and develop more rigorous EIA processes.

Establish effective coordination between government departments, with the local private sector, and among destinations.

Use fiscal instruments, including tax incentives and subsidies, to encourage uptake of SEM strategies by recreational BAU and by start-ups across the sector, with tax penalties for recalcitrant BAU operations.

Establish guidelines and standards for materials, waste management, resource use, and employment.

Ensure revenue generation mechanisms for protected areas systems, at pricing and reinvestment levels that, at the very least, meet the threshold of sustainability.

Foster implementation and maintenance of certification and eco-labeling, and its use in information systems for prospective tourists. Work with academia to implement data-gathering systems to better understand and monitor impacts and contributions of different types of tourism.

Establish monitoring systems to track ecosystem health and visitor impacts in protected areas and other critical sites.

CHAPTER 10

PROTECTED AREAS

Marlon Flores⁴³

10.1 INTRODUCTION

This chapter assesses the evidence on the contribution of Protected Areas (PAs) to the wider economy and contrasts this against the current status of financing for PAs in Latin America and Caribbean.

PAs have crosscutting effects. They contribute to the economies of LAC countries through each of the other sectors reviewed in this book: agriculture, fisheries, forestry, tourism, and hydrological services. This chapter relates the varied functions of PAs and of the ecosystem services (ES) they support to productive processes in each of those sectors. The chapter also compares the effects of contrasting management regimes — from not managed to minimally- and well-managed — on the crosscutting contributions of PAs.

The chapter illustrates how PAs contribute to sustain ES and examines the potential decline in productivity due to the degradation of ecosystems as a consequence of under-investment in PAs. To this end, three scenarios are considered: a “not protected” scenario, in which habitats are not safeguarded and, thus, likely to be degraded; a “business as usual” (BAU) scenario, where basic PA protection is available but can mitigate only low level threats; and a “sustainable ecosystems management” (SEM) scenario, with sufficient funding to support comprehensive, cost-effective PA system management plans. In the SEM case, threats are fully managed (mitigated), and new business opportunities may be created in areas like eco-certification, sustainable sourcing, and novel ES.

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Growing evidence indicates that the economic benefits of well-managed PAs are multiple: increased production (GDP) in selected sectors, more jobs in rural areas, higher tax revenues, and higher foreign exchange earnings, especially through international tourism. Additional sectors can be affected as a result of economic ripple or multiplier effects.

KEY FINDINGS

Despite gaps in the data, the existing evidence is compelling on the economic value of the ES provided by PAs. Overall, PAs raise productivity in agriculture, fisheries, forestry, hydropower, and nature-based tourism, among other sectors.

Both terrestrial and marine PAs provide restricted-take zones where biodiversity can re-build, and species heavily fished or hunted can recuperate and re-stock neighboring areas.

Further sector-based research is needed to quantify the economic benefits derived from PAs, like jobs, income, local and national tax revenues, and their role as drivers of foreign exchange earnings and investment — and on how these benefits are distributed.

BAU and SEM practices are not diametrically opposed but, rather, stages in the evolution of PA management. BAU approaches create the initial conditions upon which SEM later builds.

The transition from BAU to SEM is often feasible and cost effective, based on the hidden costs of BAU and the broader benefits of SEM.

Nonetheless, barriers to the transition from BAU to SEM can be significant, especially given the need to increase resources through national funding or self-financing mechanisms, as well as to the play of interests around the tighter regulation of natural resource exploitation under SEM.

The benefits of PAs are not equally distributed. Stakeholder involvement, empowerment of local actors, and transparency are keys to success in SEM, especially in transitioning toward this approach.

PAs under SEM can contribute to equity and poverty alleviation; women, rural communities, and indigenous peoples have been provided opportunities and have used them to build self-sufficiency.

PAs drive foreign exchange earnings and local employment, especially via tourism. Nature-based tourism in PAs has brought jobs, local development, and a modicum of prosperity to many remote sites, while contributing to GDP, tax revenues, and foreign exchange earnings.

Growing biodiversity and ecosystems markets will open significant opportunities to PA-related business. For instance, SEM can secure savings in hydropower dam operations (avoided replacement costs).

Agriculture, fisheries, and forestry benefit from PAs, even while responsible for considerable biodiversity loss, ecosystem degradation, and PA encroachment.

Forested PAs provide opportunities to generate income from concessions, fees and taxes, and payment of environmental services (PES).

High quality water resources from PAs for use in irrigation, hydro-power, and consumption are critical to human well being.

Marine protected areas contribute both to fisheries growth and to biodiversity conservation.

10.2 CONTEXT OF PROTECTED AREAS

Protected Areas

The World Conservation Union (IUCN) defines a protected area as: “An area of land and/or sea especially dedicated to the protection of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means” (IUCN 1994). IUCN determines six different management categories (Box 10.1). The 1992 Convention on Biological Diversity (CBD) describes a protected area (PA) as a geographically defined area that is designated or regulated and managed to achieve conservation objectives. Although useful, these definitions do not express the economic and social roles of PAs. They reinforce the common understanding that PAs are mostly a refuge for species unable to survive in intensely-managed terrestrial and marine landscapes.

The Millennium Ecosystem Assessment (MEA) (2005) emphasizes that PAs provide critical ES that support human prosperity and survival, like clean water, flood and storm mitigation, fish stock replenishment, and carbon sequestration. In this context, it is critical

that countries establish PA systems to protect viable populations of diverse species and representative ecosystem samples. The system-level approach aims at broadening PAs from a set of scattered sites that protect few species to a system that provides viable support to biodiversity and ecosystems at the national level.

PAs do not require exclusion of human settlements nor of sustainable use of natural resources. Cases in point are Brazil’s “indigenous reserves” and “extractive reserves.”

According to the 2009 Millennium Development Goals Report, only 12% of the planet was under some form of protection. That amounts to about 18 million km² of protected lands and 3 million km² of protected territorial waters (marine areas under national jurisdiction). Since those waters represent only a small part of the oceans, this means that less than 1% of the world’s oceans are protected.

The LAC region hosts a particularly large number of PAs (Table 10.1). Brazil alone has 1280 (excluding indigenous lands), while South America (excluding Brazil) currently has 1507 terrestrial PAs covering 22% of its land surface and 114 marine reserves. In Central America, terrestrial PAs cover more than a quarter of the land area, with Costa Rica, Guatemala, and Panama accounting for particularly

Box 10.1. IUCN Protected Area Management Categories

CATEGORY Ia. Strict Nature Reserve: protected area managed mainly for science.

CATEGORY Ib. Wilderness Area: protected area managed mainly for wilderness protection.

CATEGORY II. National Park: protected area managed mainly for ecosystem protection and recreation.

CATEGORY III. Natural Monument: protected area managed mainly for conservation of specific natural features.

CATEGORY IV. Habitat/Species Management Area: protected area managed mainly for conservation through management intervention.

CATEGORY V. Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation.

CATEGORY VI. Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems.

See detailed definitions in Annex 10.3.

TABLE 10.1. SOME STATISTICS ON PROTECTED AREAS IN THE LAC REGION

REGION	TOTAL SITES	TOTAL PROTECTED AREA	TOTAL PROTECTED LAND AREA (KM ²)	TOTAL MARINE SITES	TOTAL PROTECTED MARINE AREA	TOTAL LAND AREA (KM ²)	% LAND AREA UNDER PROTECTION
CARIBBEAN	973	80,770	36,469	370	44,301	234,840	15.5%
CENTRAL AMERICA	677	151,058	133,731	103	17,327	521,600	25.6%
SOUTH AMERICA (EXCEPT BRAZIL)	1507	2,217,725	2,056,559	114	161,166	9,306,560	22.1%
BRAZIL	1280	1,321,751	1,305,864	88	15,887	8,547,400	15.3%

Source: Chape et al. 2005

large shares of protected land (Harvey et al. 2004). The Caribbean has 973 protected sites, of which many are marine.

Globally, as well as in LAC, the number of PAs has rapidly increased. The number of PAs listed by the UN has risen tenfold in the past four decades. Similarly, in the last five decades, PAs in LAC have grown from under 100,000 km² in fewer than 100 PAs to over 5M km² in 4,400 PAs (Figure 10.1).

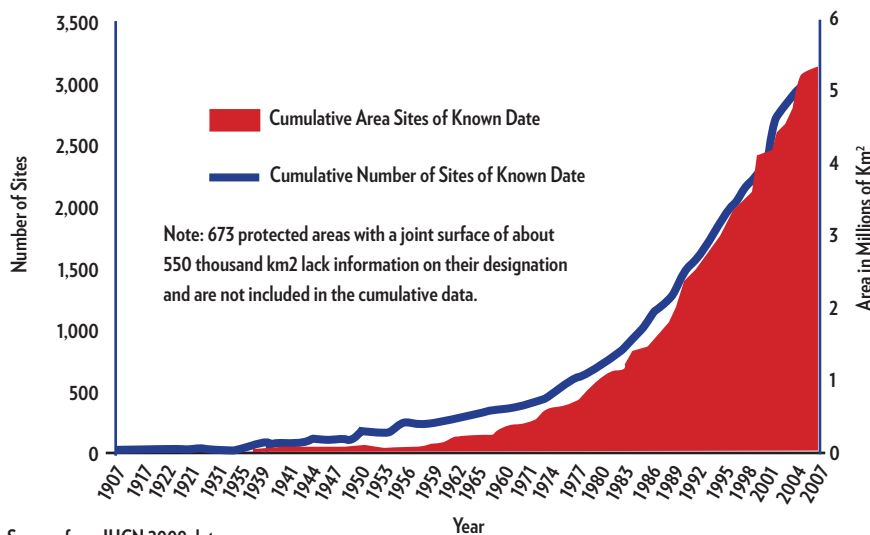
PAs shelter a large variety of organisms and ecosystems. Ecosystems provide fundamental life-support services upon which humans depend. PAs provide continuous natural habitats that enable ecosystems to function and continue to deliver those ES, though ES are not exclusively provided by ecosystems within PAs. Carbon sequestration, hydrological cycling, and erosion control are examples of ES provided outside of PAs. Table 10.2 lists some types of ES delivered by PAs.

Threats to Protected Areas

PAs face a situation of disequilibrium characterized by external pressures related to both encroachment and degradation (Alers et al. 2008). Although threats vary between sites, direct threats to PAs can be classified in two major categories: (1) habitat loss and degradation due to conversion to agriculture, and (2) unsustainable exploitation of natural resources, including logging, collection of non-timber forest products (NTFP), extraction of minerals and oil, overuse, and poorly managed tourism. In addition, there are indirect threats such as those from climate change.

Despite the growing area under protection, the current PA network is widely believed to be insufficient to curb biodiversity loss and ecosystem degradation in the region. This situation is aggravated by the existing gaps in representation (critical areas for biodiversity that are not protected), poor management capacity, lack of appropriate legal and regulatory frameworks, limited understanding of the economic impact of loss of ES, and a history of underfunding, resulting in under-staffed and poorly-equipped PA agencies.

Figure 10.1. Trends in growth in number and coverage of LAC protected areas



Source: from IUCN 2009 data.

Despite the region's many PAs, most ecoregions are considered to be threatened. For example, the 26 ecoregions of Central America are threatened by agriculture-related threats including sedimentation, extraction of firewood, hydrological changes, pesticide use, agrochemical run-off, fire, soil erosion, squatting and land invasion, hunting, and road building (Harvey et al. 2004). This is also the rule in the rest of LAC, such as in the Andean Amazon or Brazil's Atlantic forest.

Large PAs in LAC often coexist with indigenous or rural communities that depend on natural resources, creating additional challenges. However, there is evidence of effective conservation in indigenous territories. This is discussed in Section 10.4.

TABLE 10.2. MAIN ECOSYSTEMS SERVICES DELIVERED BY PAs

ECOSYSTEM SERVICES	PA CATEGORIES					
	I	II	III	IV	V	VI
Freshwater (watershed services)	•	•		•	•	•
Food (wild fruits, greens, meats, seafood)		•		•	•	•
Timber, fuel (fire wood), and fiber		•				•
Novel products	•	•		•	•	•
Biodiversity maintenance (habitat for wild species)	•	•	•	•	•	•
Nutrient cycling	•	•	•	•	•	•
Air quality and carbon sequestration	•	•	•	•	•	•
Human health	•	•		•	•	•
Detoxification	•	•	•	•	•	•
Natural hazard regulation	•	•	•	•	•	•
Development / reinforcement of cultural values		•	•	•	•	•
Diving, sport fishing, hiking, nature/wildlife viewing		•		•	•	•

In addition to the above-mentioned known threats, there are other management-related aspects that increase the vulnerability of PAs to threats, for instance, gaps in coverage, fragmentation, and weak management capacity. More important to this chapter, however, are the finance-related threats.

INSUFFICIENT FUNDING TO COVER THE COSTS OF PA MANAGEMENT

The lack of diversified funding to PAs has become a major threat to ecosystems in PAs and undermines PA benefits. Without the necessary funding to PAs, it is unlikely that national conservation strategies and benefits will become long-term operational realities. Examples of finance-related critical issues follow.

Financial gaps: PAs do not generally receive adequate funding to protect biodiversity and ecosystems. UNDP assessed the financial sustainability of national PA systems during 2008-2009, applying the UNDP Financial Sustainability Scorecard in 18 LAC countries (see Box 10.2). Existing funding, financial needs (costs), and financial gaps (i.e., the difference) were estimated for basic and optimal conservation scenarios.⁴⁴ The assessment estimated the

Box 10.2.

The Financial Sustainability Scorecard for National PA Systems was developed by UNDP in 2007 to assist governments, donors, and NGOs to assess significant aspects of a PA financing system – its accounts and its underlying structure – to show both its current status and to indicate if the system is moving toward an improved financial situation. The Scorecard could also be used by sub-national units or networks. It has three parts:

- Part I – Overall financial status of the PA system, including basic PA data and a financial analysis of the national PA system;
- Part II – Assessing the finance system;
- Part III – Scoring.

regional financial gap for basic conservation at \$317 million/year. The largest gaps corresponded to Brazil, with \$169 million and Mexico, with \$40 million. Together, Brazil and Mexico account for over 60% of the basic financial gap in the region. The PA systems in LAC have, on average, 54% of their basic financial needs covered. The gap is much wider for the optimal management scenario or what is also known as the sustainable ecosystem management (SEM) approach. This regional financial gap is estimated at \$700 million/year. In the optimal scenario, the largest gaps also correspond to Brazil and Mexico, again with approximately 60% of the financial gap. On average, the region's available funding covers 34% of the financial needs for optimal management scenario. However, Mexico, El Salvador, Argentina, Bolivia, and Costa Rica have more than 50% of their needs for the optimal scenario. Table 10.3 shows these results for 18 LAC countries.

Funding needed to expand PA systems: The establishment of new PAs will increase the financial gap even at current low levels of support. Preliminary estimates suggest that over 19 million ha of new PAs will be needed to improve ecosystem coverage in seven countries: Brazil, Bolivia, Chile, Colombia, Ecuador, Peru, and Venezuela (TNC 2007). At the average Business as Usual (BAU) investment of \$1.18/ha-year, this would widen the overall basic scenario financial gap by another \$22 million yearly.

Low and poorly diversified PA income: Historically, the majority of PAs in the LAC region have been highly dependent on dramatically low government investment and insufficient funding from

⁴⁴The basic scenario describes the minimum level of funding and management capacity required to operate key conservation programs that will sustain essential ecosystem functions in PAs. The optimal scenario corresponds to the level of funding and capacity needed to achieve fully satisfactory operation

and coverage of all PA programs: to reach and sustain optimal functioning of the ecosystems and their services. The optimal scenario describes an ideal state of the programs if all needed funding, personnel, equipment, and other resources were available to attain the short-, medium-, and long-term goals for the PAs, in accordance with the highest environmental, social, and economic standards (Flores et al. 2008).

TABLE 10.3. PA SYSTEM MANAGEMENT COSTS AND FINANCIAL GAPS IN 18 COUNTRIES

COUNTRY	PA MANAGEMENT COSTS AND FINANCIAL GAPS IN SELECTED LAC COUNTRIES (\$)				
	BAU (CURRENT FUNDING)	FINANCIAL NEEDS (COSTS)		FINANCIAL GAPS	
		BASIC SCENARIO	OPTIMAL	BASIC SCENARIO	OPTIMAL
ARGENTINA	31,309,584	39,512,820	60,366,666	8,203,236	29,057,082
BOLIVIA	5,102,653	5,374,940	9,000,000	272,287	3,897,347
BRAZIL	133,415,026	302,573,314	471,731,602	169,158,288	338,316,576
CHILE	9,194,339	17,974,193	26,754,046	8,779,854	17,559,707
COLOMBIA	18,026,595	25,150,153	42,755,260	7,123,558	24,728,665
COSTA RICA	29,645,948	31,934,374	44,000,000	2,288,426	14,354,052
CUBA	14,587,030	21,639,821	36,787,695	7,052,791	22,200,665
DOMINICAN REPUBLIC	10,380,071	22,574,294	27,974,294	12,194,223	17,594,223
ECUADOR	3,977,600	6,730,054	14,040,147	2,752,454	10,062,547
EL SALVADOR	3,803,223	4,445,738	7,557,755	642,515	3,754,532
GUATEMALA	8,339,504	16,118,443	27,401,353	7,778,939	19,061,849
HONDURAS	4,122,552	6,618,629	11,251,670	2,496,077	7,129,118
MEXICO	80,214,239	120,321,358	160,428,478	40,107,119	80,214,239
NICARAGUA	5,314,245	19,546,456	43,321,382	14,232,211	38,007,137
PANAMA	9,506,948	19,880,360	33,796,612	10,373,412	24,289,664
PARAGUAY	1,240,665	9,700,000	19,500,000	8,459,335	18,259,335
PERU	13,067,100	25,172,664	41,842,414	12,105,564	28,775,314
URUGUAY	816,000	3,409,002	4,355,947	2,593,002	3,539,947
TOTAL	382,063,32	698,676.61	1,082,865.32	316,613,291.0	700,801,99

*Federal level PAS only.

Source: UNDP 2010.

trust funds and international projects; and extremely low private sector participation at national levels. For example, based on the Scorecard Assessment, public expenditure on PAs in 19 countries (including Venezuela) account for 0.0059% of GDP (see Table 10.4). Public spending on the broader category of environment amounts to less than 1% of GDP on average in the region (Barcena et al. 2002). The level of investment in PAs by 19 LAC countries averages \$1.18/ha/year (range: \$0.00 to \$7.95/ha, in Table 10.4). By comparison, European and North American nations spend, on average, 0.08% of their national budgets on PAs, about \$28/ha/year (Wilkie et al. 2001).

Lack of skills and political commitment to improve PA financing: There are several types of financial mechanisms that can be harnessed to raise funds for PAs, but which are rarely used due to limited know-how and lack of political will. When employed, they are all too often used as stand-alone stratagems, disconnected from priority investment needs. Still, progress has been made toward rationalizing design of solutions, defining specific financial needs, and tailoring strategies to fill the gaps and address institutional capacity

issues (Analysis of Financial Needs of SINANPE, Peru 2005; Financial Strategy for the SINAC, Costa Rica, 2007; Analysis of Financial Needs of the SNAP, Ecuador, 2006; Pillars for the Financial Sustainability of the SNUC, Brazil, 2007; and Financial Strategy of the National Parks of Colombia, 2002). Cases in point are Mexico, Peru, and Colombia where sizeable increases in central government allocations to PAs have been won in recent years.

Further, there has been extremely low public and private sector commitment to introduce environmental fiscal reform (EFR)⁴⁵ to support SEM approaches in PAs; and, therefore, explains in part the almost absent private sector funding to PAs.

⁴⁵ Environmental fiscal reform (EFR) refers to a range of taxation or pricing instruments to raise revenue while furthering environmental goals. This is done by providing economic incentives to correct market failures in the management of natural resources and pollution. Broadly speaking, EFR can (1) mobilize revenue for governments, (2) improve environmental management practices and conserve resources, and (3) reduce poverty. By encouraging more sustainable use of natural resources and reducing pollution from energy use and industrial activities, EFR addresses environmental problems that threaten the livelihoods and health of the poor. Revenues raised can also be used to finance poverty reduction measures (World Bank 2005).

TABLE 10.4. PA BUDGETS, INVESTMENTS PER HECTARE AND BUDGET AS PERCENTAGE OF GDP.

COUNTRY	GOVERNMENT PA BUDGET	BUDGET/ HA*	BUDGET AS % OF GDP
ARGENTINA	16,610,320	4.54	0.0049%
BOLIVIA	73,041	0.00	0.0004%
BRAZIL	104,691,806	1.39	0.0063%
CHILE	5,705,515	0.37	0.0031%
COLOMBIA	12,600,584	1.09	0.0050%
COSTA RICA	14,302,091	7.95	0.0545%
CUBA	2,259,551	2.07	0.0050%
DOMINICAN REPUBLIC	7,103,393	5.77	0.0195%
ECUADOR	1,160,000	0.24	0.0021%
EL SALVADOR	395,404	4.09	0.0019%
GUATEMALA**	4,353,715	1.89	0.0129%
HONDURAS	677,057	0.55	0.0055%
MÉXICO	49,046,698	2.12	0.0055%
NICARAGUA	576,337	0.26	0.0101%
PANAMÁ	1,132,000	0.40	0.0057%
PARAGUAY	257,466	0.04	0.0016%
PERU	1,810,016	0.10	0.0014%
URUGUAY	606,000	3.20	0.0019%
VENEZUELA	20,628,837	1.01	0.0062%
TOTAL FOR LAC REGION	243,989,830	1.18	0.0059%

* Government budget divided by number of hectares in PAs.

** Data of CONAP only. Excludes other government institutions managing PAs

Source: UNDP 2010.

However, studies on the economic valuation of PAs and of related ES are now emerging. Such studies will help mobilize political will to improve PA funding (including EFR) and performance. For example, in Colombia a study in 2007 noted that the Water and Aqueduct Company of Bogota (EAAB) is spending \$4.5 million yearly to remove sediments, but that if the company invests in watershed protection, it will save millions. The data on the value of ES was key to winning financial support to protect the upper watershed of the Chingaza National Natural Park.

Lack of cost-efficiency: PA cost-efficiency is a critical element to achieve financial sustainability. It is essential that agencies managing PA systems address current issues related to outdated financial management systems, introduce result-oriented conservation programs linked to realistic costs, establish diversified sources of domestic revenue, and strengthen both transparency and accountability. To date, little is known about how much money PAs lose because inefficient use of financial resources.

10.3 BAU AND SEM IN PROTECTED AREAS

To help structure the analysis of the contribution of PAs to economic growth, this chapter distinguishes between two PA management approaches: Business as Usual (BAU) and Sustainable Ecosystem Management (SEM). These approaches are discussed next. In addition, to further distinguish benefits from PAs, this chapter also refers to a “no PAs” situation. In the “no PAs” scenario, when threats are present, the habitats are not protected, and, therefore, likely to be degraded, converted, and fragmented until only small patches of poor quality habitat and ecosystem function remain. The no-PAs scenario excludes other types of protection, such as indigenous territories and forest concession. For the purpose of this report, the “no PAs” is considered a BAU approach.

SEM complements the commonly used “protected area management effectiveness⁴⁶ (PAME)” approach. PAME is used to assess how well a PA is managed — primarily the extent to which it is protecting values, and achieving goals and objectives (Hockings et al. 2006). SEM brings an additional dimension of “ecosystems management,” which is useful to better understand the economic costs of ES loss in PAs; SEM thinking can build economic arguments to promote increased funding to protect biodiversity and ecosystems in PAs.

Defining BAU and SEM

Figure 10.2 is helpful for illustrating the difference between the BAU and SEM approaches. When PAs are underfunded and facing severe threats, they are unlikely to provide basic protection to biodiversity and ecosystems functions — in this case, PA management is considered to be the BAU approach. PAs in BAU have limited funding and lack management capacity; most PAs are currently considered to be in this situation. On the other hand, when funding and capacity are available to meet basic to optimal protection needs, PA management is considered a SEM approach. The shift from BAU to SEM takes place as funding and management capacity (to address threats) increases.

It is assumed that PAs are a “means” to control, or manage, threats, but not to eliminate them. For example, PAs in Ecuador such as Sumaco-Napo Galeras, Yasuní and Cuyabeno, are helping reduce the impact of the increasing threat level generated by oil exploration

46 IUCN-WCPA has developed a management effectiveness evaluation framework that provides a consistent basis for designing PA evaluation systems. The evaluation of management effectiveness is generally achieved by the assessment of series of criteria (represented by carefully selected indicators) against agreed objectives or standards. The term management effectiveness reflects three main themes: (a) design issues relating to individual sites and PA systems, (b) adequacy and appropriateness of management systems and processes, and (c) delivery of PA objectives (<http://www.cbd.int/protected/PAME.shtml>).

and extraction in the Amazon (e.g., deforestation, contamination, illegal logging, hunting, road construction). Threats are not necessarily eliminated by the PAs; threat elimination may require policy reform, law enforcement, and public and private sector action outside the PA. SEM leads to minimizing the impact of threats but not necessarily to their elimination (see Figure 10.2).

Moreover, in the “no PAs” scenario, if PAs are eliminated or new PAs are not created in areas of high biodiversity that are not yet protected, this lack of action will result in environmental damage, caused by the immediate escalation of the impact of threats. Thus, the BAU and SEM scenarios are also likened to low and optimal levels of ecological representativity.

Differences in the BAU and SEM management approaches

Although this simple Threat Impact vs. Funding & Capacity approach is convenient⁴⁷, it does not explain all the characteristics of BAU and SEM; BAU and SEM approaches also differ with respect to other aspects of PA management, as shown in Table 10.4.

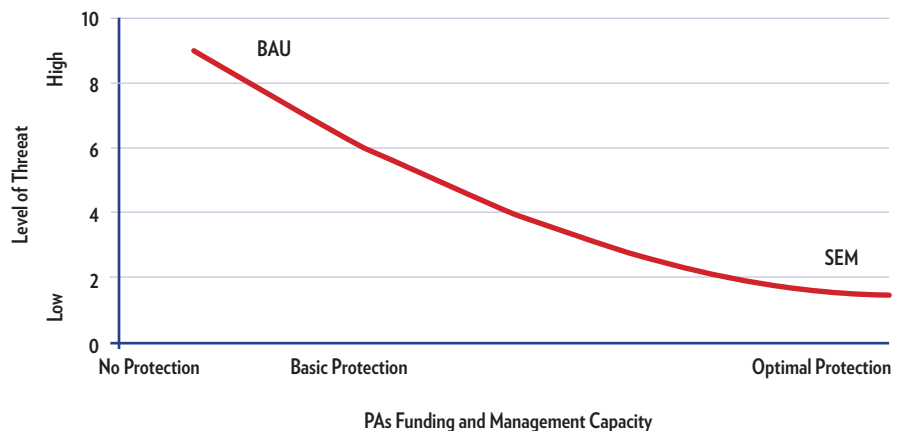
In BAU, for example, planning and management functions are typically supported by limited human, financial, institutional, and informational resources (Lockwood et al. 2006). Too often, PA conservation goals and objectives are poorly linked to conservation programs and costs, and existing budgets are not linked to programmatic priorities. All together, this makes it difficult to measure effectiveness, estimate realistic needs, and determine financial gaps.

Further, at national levels in the BAU scenario, domestic funding for PAs is often stagnant as a result of constrained national budgets, obsolete legal and regulatory frameworks, lack of transparency, poor accountability⁴⁸, as well as a lack of political will to support “greening” of national development plans. Besides, protected area budgets may simply be based on previous-year expenses, while transfers to PA system agencies are often late and less than what was actually approved; and due to limited implementation capacity, protected area agencies often fail to execute their allocated resources. It is also undetermined how much money PAs are losing as a result of the inefficient use of financial resources (both related to international and domestic funding).

47 Threat Impact vs. Funding & Capacity analysis is useful to map PAs to determine capacity building and funding priorities.

48 According to the Worldwide Governance Indicators (WGI), all countries in Latin America, with the exception of Chile, have a low rank in all six governance indicators. Ecuador, Paraguay, and Venezuela have the lowest rating in Latin America.

Figure 10.2. BAU and SEM as a function of funding and capacity levels (for threat management)



SEM is understood as an advanced management approach in which protected area management functions are more aligned with human, financial, institutional, and informational resources. In SEM, protected area’s conservation goals and objectives are linked to ecosystems conservation programs and realistically linked to funding; and, resource allocation is based on defined ecosystem-based priorities. As a result, the health of both the contained biodiversity and ecosystems improves and their benefits, in terms of increased productivity and equity, expand. By and large, the benefits of SEM outweigh its costs. Additional characteristics of BAU and SEM are included in Table 10.5. It is important to recognize that in many cases, PA management programs include both characteristics of BAU and SEM, or their approaches could be in-between the BAU to SEM axis.

There has been significant movement toward more cost-efficient PA management (SEM) in recent years. Examples include Costa Rica, Mexico, Colombia, Peru, and several states in Brazil, where national and sub-national governments are actively promoting result-oriented, cost-effective PA management and have significantly improved PA financial planning and funding. For instance, between 1995 and 2008, Mexico implemented an impressive increase in funding, which accelerated the transition of PAs from BAU to SEM. The budget allocated to PAs rose from 11 million pesos (SEMARNAP-INE 2000) in 1995 to 143 million (INE-SEMARNAP 2006) in 2000, then 984 million pesos in 2008⁴⁹ (about \$66 million). Another key feature in Mexico was institution of the Regional Sustainable Development Program by CONANP (National Commission for Natural PAs), which supports community development in and around PAs. The funding allocated to this in 2008 was about \$19 million⁵⁰). This record growth in funding significantly reduced the existing financial gap of the PA system in Mexico from \$35million to \$15 million (UNDP 2009).

49 Com. Pers. Rene Macias – CONANP 08/2008. This figure does not include the investment made by CONANP on Priority Regions for Conservation and Priority Species. All budgetary figures refer to the modified budget.

50 Exchange rate from February 2010.

TABLE 10.5. DIFFERENCES IN MANAGEMENT APPROACHES OF BAU AND SEM

BAU	SEM (OPTIMAL SITUATION)
Economic activities continue to threaten PAs, encroachment by agriculture, illegal timber harvesting, tourism development etc.	Threats are minimized
Incomplete ecological representativity.	Full ecological representativity.
Lack of inter sector collaboration, substantial institutional fragmentation (poor interaction of environmental agencies with agencies outside the environmental sector).	Strong inter-sector collaboration, delegation of responsibilities and shared leadership.
Insufficient financial management capacity and absence of diversified long-term financial mechanisms.	Sound PA financial planning and diversified long-term PA funding mechanisms are an integrated part of nat'l develop'm't agenda.
Institutions managing PA are isolated from national development policies.	Institutions managing PAs are aligned with national development policies.
Poor PA management capacity.	Strong PA management capacity.
Absent legal and regulatory framework for PA financing.	Coherent legal and regulatory framework for PA financing.
Poor compliance and no enforcement.	Strong compliance and enforcement.
Absence of transparency and accountability standards.	Standards and transparency and accountability are enforced.
Limited participation of local communities in PA management and planning and PA's benefits sharing.	Strong PA's benefits sharing amongst the civil society, including vulnerable groups.
Funding to support PA management is below basic needs or at basic level needs.	Funding to support PA management meets medium to optimal needs.
Finance and economic information is absent from the decision-making process.	Informed decision-making based on sound financial and economic information.

The current contribution of PAs to the economy in Mexico is over \$3.5 billion/year. According to Bezaury and Pabon (2009), every peso invested in PAs generates 52 pesos in the economy.

A key issue is the need to shift the regional focus to threats to ecosystems, rather than simply threats to PAs. Currently, there is no coordination mechanism to facilitate introduction of a new ecosystem-based management policy. This evident institutional gap was acknowledged by the G8/G20 Summit in Canada in June 2010, in which governments called for, in the Joint Statement, creation of an Intergovernmental Platform on Biodiversity and Ecosystem Services (The G8/G20 Summit 2010).

10.4 IMPORTANCE OF PROTECTED AREAS TO GROWTH: BENEFITS AND COSTS UNDER BAU AND SEM

PAs provide a variety of ES that result in greater productivity or other use values in a number of sectors in BAU scenarios and even more so under SEM. Examples of key services include biodiversity protection

and ecosystem health (self-sustaining or homeostatic biosphere systems); water supply and quality; maintenance of valuable wild species providing foodstuffs, medicinals, pollinators, pest control, and many other benefits; attractions for tourism; climate change mitigation and adaptation; and preservation of cultural resources. Benefits from resource-depleting interventions under BAU tend to be concentrated, immediate, and market-driven, like logging, NTFP-gathering, cattle ranching, and farming. PA benefits under SEM are more broadly distributed, long-term, and often non-market (though some are market-driven such as tourism, water supply, and carbon sequestration).

The provision of PA benefits, however, is not free; there are significant costs associated with PA management, both in terms of direct expenditures, and in terms of indirect costs or impacts, and opportunity costs (alternative uses foregone). Governments must either set aside funding for PAs every year or establish self-financing mechanisms. The tendency of direct expense to grow with improved PA coverage or quality provides an easy argument for those that choose to favor BAU with its short-term gains, which can be quite attractive, even if resource-depleting.

For example, under BAU in the Brazilian Amazon (Para, Mato Grosso, and Rondonia), forest industries are a major source of income, employment, and wealth, generating 15% of GDP and 5% of em-

ployment (Lele et al. 2002). In 1998, the forest sector in the Brazilian Amazon generated about \$2.2 billion in sales. About 70,000 people worked in extractive activities, with another 107,000 working in the processing subsector. Employment in the processing sector is distributed among sawmills (70%), plywood manufacturers (16%), laminate production (8%), and other processors (6%). For each direct job created, two indirect jobs are also generated (in transport, supplies, and services, etc.). Direct and indirect employment in forest activities amounted to 510,000 jobs in 1998. Workers in the forest industry earn an average annual salary of \$4,329, well above the Amazon average of \$1,620 and the national yearly minimum wage of about \$1000 (Amend et al. n.d.). Even though only a very small share of the revenue generated by logging goes into public coffers, the timber sector contributes about 10% of taxes collected in Para and Mato Grosso states (Barreto et al. 1998).

The Brazilian Amazon also provides an example of the way direct costs, already high under BAU and largely unmet, can pose an even greater challenge to the transition to SEM. Although State governments in the Amazon expanded the land under protection in recent years, PAs still lack capacity and resources to carry out effective protection. Shortcomings of Brazil's PA system revolve around severe under-funding: only 44% of basic needs are being funded, leaving a \$169 million annual gap (Table 10.3, earlier). This results in under-staffing and, consequently, poor policing and protection of PAs (Lele et al. 2002). WWF Brazil has reported that 23% of Brazil's PAs are at extreme risk and 20% at high risk. Illegal logging is one of the biggest sources of that risk (WWF 1999). The critical issue with respect to Brazil's PA system is the limited government attention given to PA policy and finance vis-à-vis its forestry sector policy that promotes immediate, tangible returns. In Brazil, the estimated cost of a fully functional SNUC at Federal level (Optimal scenario) is \$471.7 million, and the current funding is only 28% of what is needed (\$133 million), shown in Table 10.3.⁵¹ Additionally, \$1 billion is needed for investments in infrastructure and planning for the federal and state systems. These figures do not include the Private Natural Heritage Reserves nor are they integrated in the Union of Federal States budget (Ministério de Meio Ambiente do Brasil 2007).

It has been widely documented that humans benefit from conserving wild habitats and ecosystems such as tropical forest, wetlands, mangroves, coral reefs, and nature's goods and services as a whole. For instance, studies indicate, that "on average, for every hectare of intact or sustainably managed tropical rainforest converted, we lose 39 percent of its total economic value (TEV)" (Papageorgiou 2008).

Ecosystem valuation is not new. For example, Constanza (1997) systemized over 100 attempts to value ecosystem goods and services, using a range of methods. The results have been sometimes criticized for apparent inconsistencies in macroeconomic extrapolations and

indicators, with national or site-level marginal data. Further, studies often present impressive overall values and costs, but seldom break them down into concise, politician-friendly data to translate them into employment, income, and government revenues. Finally, in-depth scrutinizing of economic valuation design to validate assumptions and methods used is, indeed, required to overcome inconsistencies and to advance informed decision making.

Using a sector approach, this section provides evidence of the economic benefits, both direct and indirect, of PA ecosystems. The analysis looks at these benefits in terms of the potential decline in productivity due to ecosystem degradation that would result from no action or change (BAU). When possible, it assesses the impact that could be had under SEM. The importance of PAs to growth in agriculture, fisheries, forestry, nature-based tourism, and human settlements is discussed by subsections, including references to drinking water, disaster prevention, and hydropower.

Agriculture

PA ecosystems are economically important for agriculture in a number of ways. Water is critical for irrigation and other uses. A sustainable, high-quality water supply depends on well-maintained ecosystems that are often preserved within PAs. Tropical forest PAs provide natural habitats for genetically-important crop wild relatives, not to mention for many species that pollinate crops and control pests. These services are frequently under-valued; in the BAU scenario, farmers are not paying for them.

This section argues that PAs contribute essential services to agriculture and, thus, are linked to this sector. However, agriculture also requires conversion of natural habitat. Demand for food, fiber, and biofuels will continue to rise; thus, it is critical to balance converted lands with PAs, and to improve agricultural efficiency. Unbalanced conversion of natural land (BAU scenario) will lead to suboptimal agriculture, overall.

IRRIGATION

PA water resources in LAC are poorly managed, despite their contribution to agricultural production and jobs, and negatively impacted by the agricultural sector itself. Further research is needed to assess the links between reduced water quality, lower flows, and PA ecosystem management. Some results are available other regions. For instance, a study of river conservation inside and outside PAs in South Africa concluded that only 50% of rivers within PAs are intact, but that even fewer (28%) are intact outside PAs, providing insight into the positive role PAs can play in conserving river ecosystems (Nel et al. 2007). PAs can be of use in developing solutions to degradation in freshwater ecosystems. Annex 10.1 gives an overview of threats to freshwater ecosystems and the possibility of mitigation by PAs in LAC.

⁵¹ Exchange rate US\$1.00 = R\$1.77, as of 13 May 2010.

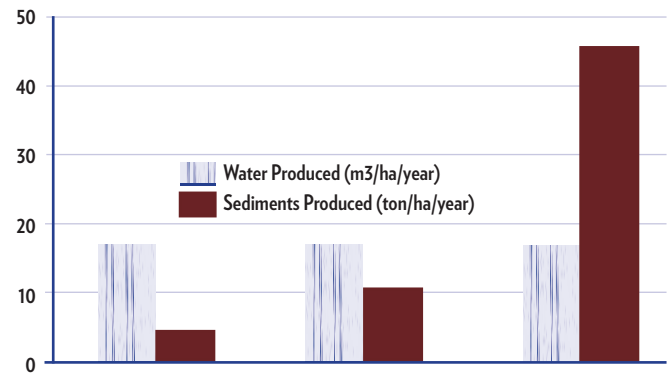
It is estimated that water availability for urban consumption in **Venezuela** could diminish by between 0.5% and 1%/year, if the combined pressure of deforestation and erosion levels currently observed in non-protected areas occur in the basins of National Parks (Gutman 2002). The reduction in water supply would also have a direct negative impact on irrigated agriculture. Well-managed PAs are fundamental to continued water supply for agriculture in the region. The following examples testify to the effects of forest ecosystems in PAs on irrigation in Colombia, Peru, Venezuela, and El Salvador.

In **Colombia**, there is evidence of major benefits from irrigation supplied by rivers of the National System of Natural Parks (SPNN) (Carriazo et al. 2003). These parks provide water directly to 31% of the population of Colombia, including the main irrigation districts. Out of the 207,089 ha with small and large-scale irrigation, 176,745 ha (85%) receive irrigation water from PAs, which accounts for 40% of water demand nationally (INAT 2002). The SPNN includes four of the six most important water systems in the country; 12 major agricultural districts use water from the SPNN. The water originating from the SPNN grows valuable crops like rice, potatoes, and peas. For example, the Districts of Córdoba and Tolima depend on water sources from Paramillo and Las Herosas Natural Parks. Both districts are among the larger rice producers and account for 37% of national rice production (FAO 2010). The value of rice produced in Colombia in 2000 reached \$521 million, 2% of industrial GDP (Espinal, Martínez & Acevedo 2005).

Farmer willingness to pay for irrigation water is reckoned at \$734 / ha/harvest for rice, \$2,782 for potato, and \$444 for peas. Clearly, water is a valued input to production. Water is also vital to stockraising, where it is used for beef, dairy cattle, and pigs. About 10% of water demand in Colombia goes to cattle (Venegas 2001).

The current BAU PA management adversely impacts water quality and quantity. In the Chingaza PA above Bogota, paramo plants help regulate water flows (CIAT 2007). Human activities that reduce paramo vegetation and forests not only affect water volumes but also generate sediment that lowers water quality. Figure 10.3 compares levels of sediment produced in PAs with good conservation (SEM), PAs with human impact (BAU,) and sites outside of PAs with heavy impact. Places with high human impact generate more sediments than PAs with good conservation, given the same level of water production. Lower sedimentation reduces water treatment costs. The Water and Aqueduct Company of Bogota (EAAB) invests \$4.5 million annually to remove sediments; it can save millions by investing in watershed conservation. The cost to improve watershed management in the PAs is only a fraction of the current costs of sediment removal. The budget for managing PAs in Colombia was quite low, about \$142,000/PA/year (Carriazo et al. 2003); it has at least doubled in recent years. Willingness-to-pay for better water quality due to conservation activity inside the PAs is about \$0.001/m³, which represents an aggregate benefit of about \$1.2 million/year (Carriazo et al. 2003).

Figure 10.3. Water and sediments produced with increasing human impacts



In **Venezuela** about 20% of the area under irrigation (450,000 ha) depends on forest ecosystems in national parks. PAs contribute 10%-30% of the water provided through irrigation systems during the 30-year lifespan of the infrastructure (World Bank 2006); that lifespan will be longer if sedimentation is low. According to Gutman (2002; cited in Cartaya and Pabón 2009), the average annual benefit from public and private irrigation systems supported by PAs in Venezuela is \$316 million over the life of the facilities. An example in Venezuela of the importance of PAs to irrigated agriculture is that of the 4,600 people living in the Sierra Nevada National Park, where local farmers benefit from 29 small irrigation systems that originate in the park (Cartaya 2007).

In **Peru**, 376,000 ha are irrigated with water from PAs, producing agricultural output worth \$514 million/year. Agricultural exports were valued at \$1.3 billion in 2005; thus 40% of agricultural exports were dependant on PAs (León 2006). It is assumed that output will decline over time due to deterioration of the water resources under the current BAU approach; research is needed to estimate the size of the decline in water supply and the impact on irrigated agriculture, if PAs continue to be underfunded.

El Salvador is an example of mismanagement of water and forests inside and outside PAs under BAU. The most densely populated country in Latin America, El Salvador struggles with land-related issues. Population pressure has resulted in multiple encroachments on PAs, leading to habitat destruction and deterioration, with conversion of forests, pollution, and overexploitation of natural resources — stemming in part from poverty and lack of environmental awareness. It is likely that some units of the National PA System no longer contain sufficient natural or near-natural habitats to warrant PA status. Of Mesoamerica, El Salvador has the smallest portion of its territory formally protected (about 75,500 ha, 5% of its area). Most Salvadoran PAs are “paper parks,” with weak legal and physical protection. Watersheds and agricultural lands are under severe pressure from unsustainable farming practices and fuelwood use. A quarter of the farms suffer high soil erosion, and 20% have significant produc-

tivity losses. In the past 20 years, the yield of a sample of fresh water springs declined by 30% (World Bank/GEF 2005).

Costs of environmental degradation under BAU to the Salvadoran economy and society include both health losses due to water and air pollution, and productivity losses from soil erosion and sedimentation of hydroelectric reservoirs and other water bodies. This cost lies in the range of \$300 million-\$400 million/year or 3%-4% of the country's GDP (Panayotou 1988). That excludes fishery losses from water pollution and overfishing, infrastructure damage from water pollution and sedimentation, loss of timber and other forest products, loss of biodiversity by deforestation, and the loss of potential tourism and recreation benefits. Lack of data prevented detailed valuation of these additional losses; however, based on fragmentary evidence and experience from other countries, it is unlikely that they will be under \$200 million/year, bringing the total estimated loss to over \$500 million/year, 5% of GDP. An expanded, well-managed PA system could, in the long run, help reduce these severe losses (Panayotou 1988).

WILD GENETIC RESOURCES

PAs host crop wild relatives of many commercially-important agricultural varieties that may be used by plant breeders to improve their qualities, from size and nutrition to resistance to cold, drought, pests, and disease. In the Andean Region, PAs are an important as germplasm banks for wild crop varieties of potatoes and other solanaceous and root crops, grains, vegetables, spices, and fruits.⁵² PAs in Mesoamerica are important for maize, bean, and squash family relatives. Two examples from Mexico illustrate the importance of wild crop relatives.

- The discovery of wild, perennial maize in Mexico's Sierra Madre del Sur in the 1970s led to establishment of the Sierra de Manantlán Biosphere Reserve in 1988 (shifting from BAU to SEM scenario). The wild maize freely interbreeds with cultivated maize and is tolerant to at least seven corn viruses and immune to three.⁵³
- Throughout the 1900s, the wild Mexican *Solanum demissum* was used to develop resistance against the fungus responsible for potato blight and to improve crop performance. More recently, genetically modified potatoes using a gene from another Mexican potato relative, *S. bulbocastanum*, are being tested for resistance to the late blight fungus (Cummins 2006). Community PAs in the pine-oak forest in the Sierra Norte of Oaxaca, Mexico, are well known as a center of potato relative diversity.

These plant genetic services are possible because protected ecosystems provide habitat for crop wild relatives. BAU practices, such as

fragmentation and deforestation, are resulting in smaller and more isolated populations of crop wild relatives and declining diversity within these populations. Fragmented habitats, cultivated fields, and timber plantations are less likely to sustain a robust and representative gene pool. SEM PAs are critical to supporting ecosystem function and, thereby, to providing continued plant genetic services. Annex 10.2 includes a list of countries, parks, and links to crop wild relative and landscapes in LAC.

Fisheries

Marine PAs (MPAs) are a tool for improving fisheries management and marine protection with seasonal and long-term closures, and to raise income for local fishers (CEFAS – Centre for Environment, Fisheries & Aquaculture Science). They can protect spawning and nursery areas, preserve vulnerable habitats, reduce fishing pressure inside MPAs, restore diversity, and contribute to fisheries management research.

MPAs that protect essential fish habitats provide some insurance against overexploitation elsewhere. Protecting spawning and nursery grounds is a well-established tool of fisheries management (Gell and Roberts 2003). The potential for MPAs to act as insurance against overfishing has been attracting growing attention, especially for stocks whose status is uncertain or in regions where fisheries-wide enforcement is challenging. The movement patterns of target species are critical in determining the effectiveness of MPAs at protecting stocks and generating spillover to support fisheries in surrounding areas. Networks of MPAs may be essential for populations that depend on other sites as sources of eggs and larvae (Murray et al. 1999). MPAs are challenging, and costly to patrol and monitor under BAU; it is difficult to determine their effectiveness. Most monitoring of MPAs is done in tropical and sub-tropical seas (Fogarty and Murawski 2005). Fish there, typically, live in specific habitats (e.g., reef systems) and stay put; the permanence of the fish is critical to MPA success.

Well-designed and managed MPAs may allow fish stocks to increase, with tangible benefit to local fisheries. Establishing MPA networks is a viable way to enhance their efficiency. Recent findings in marine ecology suggest that a single general design of a network of reserves of moderate size and variable spacing can meet the needs of most stakeholders interested in marine resources (Halpern and Warner 2003). By integrating large-scale MPA networks into fishery management, fishery declines can be reversed, while providing urgently needed protection for marine species and habitats (Gell et al. 2003).

The Apo Island (Philippines) reserve studies by Russ and Alcala (1998, 2001, 2004) are among those that provide evidence of enhanced fish catches over long periods, as a result of spillover. Since establishment of the MPA in 1995, a ten-fold increase in fish stock

⁵² WWF food stores.

⁵³ Ibid.

has been recorded in surrounding areas. Similar results are reported from Fiji, where a locally-managed MPA network has led to tripling of fish catches and a 35% increase in local income over only three years (Mulongoy and Gidda 2008).

While no-take reserves and networks are potentially valuable fishery management tools, knowledge gaps can prevent the establishment of MPAs by lowering confidence that they will sustain surrounding fisheries (such knowledge gaps are typical of BAU). According to Sale et al. (2005), the planning of MPA locations, sizes, and spacing is currently decided, to a large degree, by the natural geography of habitats, compromises among different user groups, issues of compliance and governance, and much “educated guesswork” on ecological aspects. In addition to knowledge gaps, the absence of coherent governance frameworks and poor enforcement (the BAU scenario) raise questions regarding the effectiveness of MPAs.

At the global level, there are examples of transitions from BAU to SEM that have improved biodiversity protection, ecosystem function, and local fisher income in MPAs. A study of 44 fully-protected marine reserves and four large-scale fisheries closures showed an increased species diversity of both target and non-target species; an average increase of 23% in species richness was documented. The increased biodiversity was associated with large gains in fisheries productivity; a four-fold average increase in catch per unit effort was seen in fishing areas surrounding reserves (Worm et al. 2006).

Evidence is emerging that MPAs are also a useful tool for maintaining coral cover, as well as for protecting varied coastal and inland fisheries, and the reefs, mangroves, sea grass beds, and forests that support them. In order to illustrate the relation of MPAs to fisheries in the LAC region, examples of positive and negative impacts of MPAs are presented from the Caribbean, Venezuela, Panama, and the Amazon. A case from Indonesia is also considered.

Coral reef MPAs: Selig (2010) compiled a global database of 8,534 live coral cover surveys from 1969–2006 to compare annual changes in coral cover inside 310 MPAs with those in unprotected areas. On average, coral cover within MPAs remained constant, while coral cover on unprotected reefs declined. The results of the study also indicate that older MPAs were generally more effective in preventing coral loss (initially, coral cover continued to decrease after MPA establishment). Coral cover continued to decline for about 14 years after protection started in the **Caribbean**, possibly due to the time needed for the ecosystem and its organisms to rebound from previous over-exploitation. Selig concludes that the effectiveness of MPAs in preventing coral loss depends strongly on the duration of protection. This is consistent with earlier findings on commercial fish stocks in Europe and southern Australian reef communities.

Mangrove ecosystems are believed to be the source of large capture fisheries outputs. In the **Caribbean**, the biomass of several commercially important species was found to be more than double in areas

when adult habitats were connected to mangroves. For example, the blue striped grunt presence was found to be 26 times greater on reefs near healthy mangroves (SEM). Under a BAU scenario, species such as the rainbow parrotfish disappeared after mangrove forests were removed (www.panda.org/news_facts/newsroom/index.cfm?uNewsID=11035).

In **Venezuela**, approximately 15,000 ha of mangrove ecosystems exist in MPAs (i.e., Morrocoy, Mochima, Laguna de Tacarigua, and Archipelago de Los Roques marine national parks). There, mangrove degradation has been conservatively estimated at 500 ha/year under BAU. The value of potential losses has been estimated at \$12 million over a 30-year period (Gutman 2002 cited in Cartaya and Pabón Zamora 2009). In National Park Morrocoy, the extraction and sale of mollusks and other species from the mangrove forest generate 376 seasonal jobs (Cartaya 2001). During harvest season, fishers and middle-market workers can earn an extra monthly income of about \$140 and \$485 respectively (FUDENA 2004). Similarly, in National Park Laguna de Tacarigua, annual fish catch is estimated at \$1.3 million and fisheries employ 41% of the work force in the area (Salvato et al. 2002). Assuming that these MPAs improve management (transition from BAU to SEM) to progressively eliminate mangrove degradation, the catch may increase and generate additional benefits to local fishers. In these cases, promoting SEM will make economic, social, and environmental sense, while BAU would likely eliminate these values over time.

In **Panama** the Coiba National Park (CNP) was established in 1991 and remained in BAU (limited or no management and low investment) for several years. In 2004, the park was officially given full PA status. A management plan was introduced (shift to SEM started). In total, of a surface area of 254,822 ha, 79% is MPAs. An adjacent area is under the category of Special Marine Protection Zone (SMPZ) with 160,000 ha. CNP fisheries are now being managed (artisan fishers are allowed in some parts). A recent valuation study of the CNP estimated that fisheries in the park generate 275 direct jobs, and an average income of \$260/person (Conservation Strategy Fund, Technical Series 16, Ricardo Montenegro, 2008). The total generated by the park’s fisheries was \$7.2 million in 2007. The average monthly income of fisher households settled around the park was estimated at \$327, contrasting with the average of \$147 outside the area. The net value of fisheries projected for the next 20 years, assuming that the park continues under SEM, is \$20 million. It is expected that both the fisheries and tourism sector will continue to grow and more jobs will be created.

Terrestrial PAs for inland fisheries are also important. Studies in the **Amazon** show the importance of establishing extractive reserves as a way to implement community-based fisheries management. The most well-known case is the pirarucu (*Arapaima gigas*). Presently, pirarucu is endangered because of heavy fishing (under the BAU scenario) since the colonization of the Amazon (Santos et al. 2006 in

Teixeira 2002, 2008). It is a very large fish and its population is fast decreasing. Community-based management in PAs (shift to SEM) is helping to rebuild stocks and sustain income for people living in or near PAs.

On the other hand, it is not clear if MPAs can support all fishery management objectives simultaneously. Similarly to terrestrial PAs, they can have negative effects by preventing harvesting in no-catch areas, thus impacting people's livelihoods. A 2005 study by ICRAN et al. (Lutchman et al. 2005), notes that the Sufriere MPA in St. Lucia has significantly increased fish stocks since its establishment (shift to SEM). Although this reserve will eventually provide sustainable benefits to local fishers, it required that 35% of fishing grounds be placed off limits, imposing a cost on local fishers in the form of reduced catch in the interim (and higher fuel cost due to longer travel). This could have been prevented by a temporary financial support policy to compensate fishers for losses during the transition from BAU to SEM.

Forests

Forest in PAs includes many different types of vegetation: tropical wet and moist forests, cloud forests and dry forests, and coastal swamps and mangroves. Across LAC, PAs are home to the richest biodiversity on Earth. This richness, however, is threatened by deforestation that occurs mainly through illegal logging, and slash-and-burn practices in PAs. Moreover, PAs are encroached upon and degraded as a result of deforestation around them. In addition, building infrastructure, especially roads and dams, contributes to deforestation in and near PAs. Such situations are a consequence of traditional BAU practices in PA management.

TRADE-OFFS BETWEEN BAU AND SEM IN FOREST RESOURCE MANAGEMENT

From a global perspective, it may be that, in most cases, the economy would be better off by conserving more at the margin (Paga-gourgiou 2008). For every hectare of tropical forest lost, the economy loses more than it gains. The lack of markets for ES hinders the transaction needed to reach efficiency. Forest ecosystems can provide multiple services; when their value is considered, PAs are often an optimal land use.

For example, values were obtained for a variety of benefits — timber and NTFP, water supply and regulation, recreation, and the maintenance of both carbon stocks and endangered species — for forests under SEM management regimes in Selangor, Malaysia. After comparison with two methods of reduced-impact logging, conventional high intensity logging was associated with higher private benefits at least for one harvesting cycle, but reduced net social benefits at national and global levels, due to the loss of NTFP, flood protection,

carbon stocks, and endangered species. All together, the total economic value (TEV) of the forest was 14% greater under BAU than when placed under SEM (Kumari 1994 in Balmford et al. 2002). This is a case in which BAU was still preferable, at least for the moment, despite significant SEM values.

In a similar case, low-impact logging in Cameroon was compared with more conventional yet extreme land uses. Private benefits favored conversion for small-scale agriculture. However, it was evident that net benefits including those from NTFP, sedimentation control, and flood prevention were higher under SEM, as well as carbon sequestration, bequest, and existence values. The total economic value (TEV) for the SEM option was 18% greater than for the BAU option of small-scale farming (Yaron 2001 in Balmford et al. 2002, 2004).

The following subsections provide an overview of BAU and SEM cases of PA-related forest contribution to economic growth, in terms of reducing deforestation and generating income to governments through concessions, taxes, and carbon storage.

REDUCTION OF DEFORESTATION

Examples from Costa Rica, Mexico, Peru, and Guatemala are included in order to illustrate how PAs and community forests in them can be the basis of strategies to reduce deforestation.

Andam et al. (2008) evaluated the impact on deforestation of **Costa Rica's** PA system between 1960 and 1997, and found that protection reduced deforestation: about 10% of the protected forests would have been deforested had they not been protected. Mas (2005), using a method which allows mapping of a buffer area surrounding a PA that presents similar conditions with respect to a set of environmental variables, assessed the effectiveness of the Calakmul Biosphere Reserve, a PA located in SE **Mexico**. The annual rate of deforestation in that PA, as well as in the standard buffer area (based upon distance from the PA only) and the "similar" buffer area (taking into account distance along with some environmental variables,) were 0.3, 1.3 and 0.6%, respectively. These results showed that the PA was effective in slowing land clearing, but that the comparison with the standard buffer area gave an over-optimistic vision of its effectiveness.

Oliveira et al. (2007), using an expanded Carnegie forest damage detection system⁵⁴, showed that, between 1999 and 2005, disturbance and deforestation rates in the **Peruvian Amazon** averaged 632 km²/year and 645 km²/year, respectively. However, only 1% to 2% occurred within natural PAs; indigenous territories had only 11% of forest disturbances and 9% of the deforestation; and, recent forest concessions effectively protected against clear-cutting. Although there have been recent increases in disturbance and deforestation

54 Carnegie Landsat Analysis System, CLAS, <http://jasnerlab.stanford.edu>

rates, land-use policy involving PAs and remoteness are serving to protect the Peruvian Amazon.

Bray et al. (2008) tested the hypotheses that community forests and PAs are strategies to reduce deforestation. The authors evaluated the community-forestry hypothesis and the PA hypothesis in community forests with commercial timber production and strict PA approaches in the Maya Forest of **Guatemala** and **Mexico**. They concluded that long-inhabited community forests managed for timber can be as effective as uninhabited parks at delivering long-term forest protection, and more effective at delivering local benefits. The study compared 19 communities and 11 PAs in periods from 1988 to 2005. Statistics on deforestation rates, logistic regression analyses, LUCC maps (satellite images), data on local economic impacts, and ethnographic research provided the supporting evidence for the conclusion.

FOREST CONCESSIONS AND TAXES

For many countries with considerable forest resources, income from taxes, timber, and forest products is low. Low tax revenue sends incorrect signals to the market and has a negative impact on government expenditure for forest management, which may result in forest resource degradation, including those in PAs (the BAU scenario). When taxes and fees on timber and other forest products are set at appropriate levels, governments have a vested interest in sound forest management, sustainable commercial logging, and prevention of illegal activity, to ensure future revenue flows. This includes revenue from PAs that allow sustainable use of forest resources (e.g., extractive reserves in the **Brazilian Amazon**). Lost revenues due to illegal logging under BAU can cost governments and economies millions of dollars yearly.

Income from taxes on sustainably-managed forest PAs can be an important source of income to governments. However, in addition to low revenue returns in LAC and in most of the developing world, this potential remains largely untapped (the BAU scenario) and represents significant losses from foregone taxes. This situation is due to significant gaps in the legal and regulatory frameworks, including obsolete tax collection systems. For example, a study funded by the World Bank estimated the direct annual financial losses incurred by governments to illegal logging and related corruption at \$12 million-\$18 million for **Honduras**, and \$8 million-\$12 million for **Nicaragua**; where the annual gross economic value of “clandestine timber” is estimated at \$55 million-\$70 million for Honduras, and \$20 million for Nicaragua. These substantial losses could be minimized by introducing new PAs established under management regimes similar to the extractive reserves and national forest (*flonas*) of Brazil.

Logging is the primary means by which market benefits of tropical forests are realized. Logging also constitutes a significant component of tax revenues in many forest-rich developing countries such as Brazil,

Bolivia, and Peru. However, the estimated proportion of illegally harvested wood (in 2002) in Bolivia, Brazil (Amazon), and Colombia was 80%, 85%, and 42%, respectively (Fern 2002; Smith, W. 2002).

The introduction of forest concessions in PAs under special regimes has major potential in terms of public revenues. In Brazil, current PAs comprise approximately 28% of the Amazon. Most of these areas are indigenous reservations, part of the national system of conservation units (SNUC). Of the protected regions, only production reserves (3.2% of Amazonia) currently allow logging. Some 72% of the region has no protection and could, in theory, be allocated for timber production, while simultaneously expanding PAs. Studies indicate that 23% of the Brazilian Amazon could be established as FLO-NAS, connected to PAs. In addition to indigenous reserves, where logging is already permitted, other existing PAs in the Amazon region can be used to establish FLONAS-based buffer zones for fully protected parks and reserves, and to generate revenues (Verissimo et al. 2002; Thurston et al. 2006).

Logging concessions in National Forests (a type of PA) in Brazil is a case in point. The Jamari National Forest (JNF), in Rondonia, was the first case. A federal self-sustainable conservation unit, the JNF has 220,000 ha, of which 90,000 ha has been subject to a forest concession as part of the government strategy for sustainable public forests management (a SEM approach). Sustainable forest use is part of the JNF Management Plan, approved by IBAMA in 2005. According to Brazilian law, revenues from forest concession within national forest are shared by the Chico Mendes Institute, 40% (conservation of biodiversity), the State where the concession is located, 20%, the municipal government, 20%, and the national Fund for Forest Development 20% (Brazilian Forest Service).

According to the Brazilian Forest Service (SFB), the forest concession area planned for the BR 163 District in 2010 is 8.9 M ha. The annual value of the potential output of this concession (2,881,061 m³) is estimated at \$576 million. Further, the potential yearly revenue is estimated at \$64 million, and the potential effect on direct and indirect employment is creation of 28,000 and 43,000 jobs, respectively.

These studies indicate that, under sound standards for granting access to timber firms and establishing appropriate taxation levels, creation of an indemnity fund will be feasible. The proceeds of the concession would be deposited in the indemnity fund and, by the end of the harvest period, could be between \$140 million and \$1.3 billion. This low-impact controlled logging SEM model, combined with the tax scheme and the indemnity fund, provides the capability of generating an optimal long-term pattern of increased tax revenue to governments. For example, the fund's resources can be used to finance forest projects in PAs and buffer zones such as plantation forestry or conservation easements (Proposed by Katzman and Cale 1990 in Thurston et al. 2005), which will also help decrease losses from illegal logging. Although the institutional and regulatory framework

needed to establish the fund will require work, such a combined SEM model could be much more attractive to decision makers. Nevertheless, managing timber carries risks to biodiversity and ES, as from increased hunting, susceptibility to fires, and disease (Nepstad et al. 1999, 2004; Pattanayak and Wendland 2007).

CARBON STORAGE

Most recently, in light of governments taking action on mitigation and adaptation to climate change, PAs have emerged as one of the strategies for climate change mitigation. PAs provide an important carbon storage service; millions of tons of carbon are accumulated in PA forests. The value of such services and possible payment for this sequestration is the center of current debate.

Forest clearance contributes 20% of global CO₂ emissions. Reducing forest loss lowers emissions and, thus, is a critical service provided by PAs. Payments for carbon storage in PAs could mean a significant revenue stream to developing nations with standing forest (i.e., foreign exchange transfers and funding to pay for the transition to SEM). The argument for that is valid if PAs are under direct threat of deforestation. Direct threats mainly include illegal logging, and slash-and-burn practices. In this context, it is fundamental to understand the extent to which PAs are, in fact, subject to deforestation (IPCCF 2007).

It is also important to make a distinction between the carbon contained by mature forests in existing PAs, and the carbon captured by reforestation when new PAs are created in areas that were deforested. Both may be linked to incentives from REDD-related programs (Reducing Emissions from Deforestation and Forest Degradation) based on a system of compensated reductions (e.g., Forest Carbon Partnership Facility). Funding would flow from developed to developing countries to support forest conservation.

A recent UNEP study assessed forest loss within the PA network of the humid tropical forest biome during 2000-2005 (Campbell et al. 2008). It concluded that the largest forest area loss was observed in the Neotropics (most of LAC), which hold the greatest amount of standing forests. The rate of observed deforestation was estimated at 2.39%. The study estimated that, during the same period, over 1.7m hectares were cleared within PAs in the humid tropics (0.81% of the forest they contained). The study also found that the deforestation rate in neotropical PAs is low (0.79%), but more than half the global total loss of humid tropical forest from within PAs occurred in this region. About 75% of emissions from deforestation in PAs come from the Neotropics.

Despite the persisting forest loss in PAs, PAs of the humid tropical forest biome contained an estimated 70 Gt of carbon. Neotropical PAs had higher carbon stocks on average, totaling more than twice the combined carbon stocks in PAs of the other regions. Consequent-

ly, improving the effectiveness of forest PAs⁵⁵ (transition from BAU to SEM) in the region has significant potential for revenue generation and foreign exchange earnings (Campbell et al. 2008). The following examples of Venezuela, Colombia, Chile, Brazil, Bolivia, and Mexico illustrate the value of carbon sequestration in PAs.

In **Venezuela**, preliminary reports estimate the value of the stored carbon in the Canaima National Park at \$1 billion, Imataca Forest Reserve at \$94 million, and for Sierra Nevada in **Colombia** at \$4.5 million (Bevilacqua et al 2006; Gutman 2002; World Bank 2006). Forested areas in **Chile** include a range of forest types, which have different carbon storage capacities. Figueroa (2007) estimated the value of the carbon sequestration service provided by forest PAs in Chile at \$414 million.

In **Brazil**, the Amazon Region Protected Areas Program (ARPA) was created by the Brazilian Government in 2003, with GEF support to protect 50% of the remaining Amazon forests. ARPA supports the National System of Protected Areas (SNUC). Over the decade 2003-2013, ARPA aims to protect 500,000 km² of natural ecosystems, mainly forests. Despite its clear benefits to the conservation of biological diversity and protection of great forest carbon stocks, little is known about ARPA's role in the reduction of greenhouse gases. In order to determine ARPA's contribution to carbon sequestration, historical deforestation rates between 1997 and 2007 were used to estimate future deforestation based on scenarios for 2050. The author concluded that the PAs created by the federal government between 2003 and 2008 (including those supported by ARPA), will reduce emissions from deforestation of 3.3 1 B tons of carbon, by 2050. From this expected reduction, 12% can be attributed to the 13 PAs created by the ARPA Program. The contribution of PAs in the Amazon is, therefore, crucial to reducing deforestation in the Amazon and the associated carbon emissions implicit in such a land-use change (Soares et al. 2008).

Bolivia's Noel Kempff Climate Action Project is establishing credible, verifiable methods to quantify greenhouse gas benefits of land-use change and forestry projects. The project was developed under the United Nations Framework Convention Climate Change (UNFCCC) to conserve natural forests that would otherwise have been subjected to continued conventional logging and agricultural conversion. Periodic monitoring of relevant carbon pools recurs over the 30-year project life (in 1999, and then every five years) to establish the difference between the with-project and without-project scenarios (Brown et al. 1999).

In **Mexico**, according to Bezaury and Pabón (2009), the carbon existing on federal PAs, which is about five times the 2004 emissions pro-

55 Potential performance-based payments for having reduced emissions from deforestation and/or forest degradation through REDD programs will depend on country capacity to (a) demonstrate "ownership" on REDD and adequate monitoring capacity, and (b) establish a credible reference scenario and options for reducing emissions. (<http://www.forestcarbonpartnership.org> accessed May 2010)

duced by the country, would have a value of \$28 billion at the average price paid by the international market in 2007.

Information on the value of stored carbon at the regional level in LAC is incomplete. A recent study by FAO (2009) estimated the value of stored carbon in six countries ranging from small to large at \$607 million. This information is in Table 10.6.

While these examples illustrate the potential benefits of improving forest conservation in PAs with a shift from BAU to SEM, further research is needed to assess the effectiveness of PAs in reducing deforestation and the viability of mobilizing carbon-based financing. Any such funding flows would be in addition to those from the better-tested mechanisms of revenue generation from forest concessions, taxes, and PES, among others. The cost of shifting from current BAU to SEM in PAs may be significant; but it is certainly not unaffordable.

Nature-based Tourism

This subsection discusses the contribution of PAs to nature-based tourism (NBT) and through the analysis to the contribution of tourism in general to growth, which is presented in the Tourism Chapter. NBT, also known as eco-tourism, offers experiences directly related to natural attractions. NBT includes “experiencing nature on various levels: simple adventures, learning about and appreciating man-nature-land relationships and getting back to nature” (www.vcc.vic.gov.au/2008vcs/glossary.htm). NBT is often combined with other categories of tourism.⁵⁶

PAs provide natural attractions around which NBT is organized. Without the attractions, PA-based NTB will not be possible. PAs provide continuous habitats with wild plants and animals, exotic foods, fresh water and air, viewscapes, and cultural services essential to NBT. Tourists find NBT experiences —trekking, wild life viewing (including bird-watching and whale watching), scuba diving, sport fishing, hunting, whitewater rafting, kayaking, and canoeing— more valuable when they take place in healthy ecosystems, such as those found in PAs. A recent study of 138 Caribbean destinations found that the establishment of marine PAs (MPA) significantly increased scuba diving tourism (Worm et al. 2006). This has been corroborated by studies from Belize, Costa Rica, Dominica, and Ecuador, which indicate that for 50%-70% of tourists, PAs were an important factor in their choice of destination (Boo 1990 in Dharmaratne et al. 2000), and in Costa Rica, 66% of all tourists going to the country between 1992 and 1996 reported visiting a PA.

⁵⁶ Inclusive tourism categories according to GNABTA: ethnic, cultural, historical, environmental, recreational, and business.

TABLE 10.6. ESTIMATED VALUE OF CARBON STORED IN FOREST IN SELECTED COUNTRIES IN LAC.

COUNTRY	NO. OF HECTARES OF FOREST (THOUSANDS)	CARBON IN BIOMASS (MILLION TONS)	ESTIMATED VALUE (\$ MILLION) ¹
CUBA	2,713	347	2,734
DOMINICAN REPUBLIC	1,376	82	646
NICARAGUA	5,189	716	5,642
PANAMA	4,294	620	4,886
BOLIVIA	58,740	5,296	41,732
BRAZIL	477,698	49,335	388,760
TOTAL	859,925	77,066	607,280

Source: FAO 2009.

¹ According to Hamilton et al. (2010), prices for forest carbon credits ranged from \$0.65/tCO₂ to more than \$50/tCO₂, but over time, the volume-weighted average price used for this calculation was \$7.88/tCO₂.

NBT is one of the fastest growing segments of the tourism industry with an annual growth rate of 10%-30%; currently, over 40% of all international tourists are nature tourists (WTO). NBT-related activities in PAs have an economic value derived from direct use of or interaction with PA ES. This value can be measured using indicators such as spending, employment, tax revenues, and foreign exchange earnings. There is evidence that PAs make a significant contribution to economic growth even in conditions of severe under-funding (BAU practices); it is assumed that if PAs shift to SEM practices, NBT will generate greater economic value. For this report, it is assumed that PA-based NBT can be undermined by insufficient investment in the conditions required to manage NBT and the supporting PA well (BAU scenario, characterized by significant negative externalities).

There is abundant information in LAC about benefits related to NBT in PAs. The following examples provide evidence of the economic impact of NBT on PAs, in terms of jobs and income, foreign exchange, economic multipliers, and funding.

JOB CREATION AND INCOME

NBT creates a range of economic opportunities in rural areas, mainly by providing small-scale business opportunities to local populations and employment in service sector jobs (though mostly low-skilled). In **Mexico**, for example, according to the Tourism Secretariat (2000), tourism (including NBT) generates 1.8 million jobs. In the US, the travel and tourism sector is vital to the US economy; it is the third-largest sector in terms of employment representing approximately 17 million jobs (Travel Industry Association, Discover America Partnership: <http://tia-dap.org/about.aspx>).

Venezuela's Morrocoy National Park receives some 1.5 million visitors annually. The flow of tourists has a significant effect on the local economy. The average expenditure per visitor in Morrocoy, in 2001,

was \$135, for an annual total of \$203 million. During weekends, because of tourist arrivals, the population in the nearby town doubles; the local population provides the variety of supporting services required. It is estimated that 5,000 permanent jobs have been created in areas adjacent to the national park (half the employment in the area); 80% of the area's tax revenues come from tourism-related activities (Cartaya and Pabón 2009). The most visited PAs in the country, like this one, provide 30%-50% of local jobs. Table 10.7 illustrates Cartaya and Pabón's (2009) findings on job generation by NBT in Venezuelan PAs.

Venezuelan PAs generate many service sector jobs, thus increasing household income, mainly via tourism-related business in PAs. During the high season, households can double their incomes. Cases in point include Canaima National Park, where monthly household incomes go from \$103 to \$246, and at NPM from \$207 to \$606 in high season (Cartaya 2007 in Cartaya and Pabón 2009).

The Madidi National Park (NPM) in **Bolivia**, established in 1985, encompasses 18,957 km² in the north-west of La Paz Department. Before and during the first years after the establishment of the park, under the BAU scenario, uncontrolled timber extraction was growing at an impressive rate. Slash-and-burn and subsistence agriculture, with intensive use of unsuitable agricultural systems brought from the highlands by settlers, was the only other livelihood of the communities. Jobs were extremely scarce; sawmills and logging were the most prominent sources of temporary employment for the local population. The establishment of the NPM and a shift to SEM has had a significant impact in terms of both conservation and improvement of local livelihoods. A recent study estimated that NPM and the surrounding ANMI (Natural Area of integrated Management) generated over 1,600 tourism-related jobs and total receipts from tourism of \$2.4 million in 2007 (Escobar et al. 2009).

According to the Vice-Ministry of Tourism of Bolivia, tourism grew 10% between 2004 and 2007. Over 1.5 million tourists visited Bolivia in 2007 (one third were foreigners), leaving \$292 million in foreign exchange earnings. A total of 82,770 visited PAs (16% of foreign visitors). It is estimated that tourism in PAs in Bolivia generates 19,800+ jobs and \$50 million in GDP (Escobar et al. 2008).

In **Chile**, the effect of international tourism on the national economy was estimated two ways: first, by the number of tourists who visited PAs in 2005⁵⁷ times their daily expenditure; second, by assuming that all tourists coming to Chile are motivated by the existence

TABLE 10.7. EMPLOYMENT FROM NBT IN PROTECTED AREAS IN VENEZUELA

NATIONAL PARK	BENEFICIARIES	EMPLOYMENT
LOS ROQUES	Local people	40% population between 18 and 70 years old
MOCHIMA	Local people	35% of the population live from tourism
CANAIMA	Local people, Valle de Kamarata (1996)	39% of 328 households receive incomes from tourism, benefitting 544 people (43% of the population in the area); 108 of 157 workers work in tourism (85% men) as guides, drivers, cooks, etc.
	Community Tourism Program (PAT)	57 households associated in tourism cooperative (Cooperativa Emasensen)
SIERRA NEVADA Y LA CULATA	Community tourism program	135 household enterprises; 1,256 beneficiaries in 28 communities
SIERRA NEVADA	Local people (Gavidia, Los Nevados)	236 jobs
MORROCOY	Local people in the buffer zone	5,051 permanent jobs and 1,719 during high season, totaling 6,730. Generates about 50% of the jobs in the municipality
	Local people	80% of the households receive income from tourism activities. 58% of jobs are tourism related

Source: Bioparques, various years; Ecology & Environment 2002a and 2002b; Programa Andes Tropicales, unpublished statistics; Cartaya et al. 2002; Medina 2001

of PAs. Thus, that all tourist expenditures in Chile are due, in part, to having PAs. The annual contribution of this sector was estimated at \$54 million and \$336 million, respectively. In addition, the contribution of domestic tourism in PAs was estimated at \$10 million annually (Figueroa 2007). Considering the financial gap of the PA system in Chile, estimated at \$8.8 million, half the basic conservation needs (Table 10.3), it appears that the Chilean PAs are under BAU practices. It is assumed that by improving management toward SEM, the Chilean PA system will have an enhanced capacity to handle sustainable NBT tourism and that income from tourism will progressively increase. On the other hand, if these PAs are neglected, remaining under BAU, revenue from tourism may decline due to ecosystem wear and tear.

TAX REVENUES

Perhaps the most important economic impact of PA-NBT to local and national governments comes in the form of fees and taxes, including income taxes from people working in the NBT sector, and other proceed types including property tax, VAT, export tax, entry fees, and royalties from concessions. In the US, for example, the travel and tourism industry generates about \$105 billion in tax revenues yearly.⁵⁸ Data on tax income in LAC is not yet available and revenues are severely undermined by BAU practices: poor investment in tourism in PAs and the conditions of absent or non-functional tax collec-

57 TE=DE*ND*NV. TE (total expenditure), DE (daily expenditure), ND (number of days of stay) and NV (number of visits).

58 Ibid.

tion systems. This critical area of finance policy and implementation area needs research and policy action.

FOREIGN EXCHANGE EARNINGS

Tourism is important to developing countries because the sector is a main “export”— foreign exchange earner — for 83% of developing countries. It is the leading export for many of the poorest countries. In the world’s 40 poorest countries, tourism is the second most important source of foreign exchange, after oil. Over the past decade, tourism has been “the only large sector of international trade in services where poor countries have consistently posted a surplus.” “International tourism is increasing by 9.5%/year in developing countries, compared with 4.6% worldwide” (The International Ecotourism Society 2000). The contribution of NBT to LAC is most visible in terms of GDP and foreign exchange gains on small islands with a solid base of NBT. In larger countries with more diversified economies, the profile of NBT will be lower. Table 10.8 gives tourism as percentage of GDP and of exports in selected countries.

In **Costa Rica**, though only \$12 million was spent annually on PA maintenance in 1991 (a BAU setting), foreign exchange generated by parks was over \$330 million from 500,000 visitors (Dudley et al. 2008). Given the recognition of the importance of PAs in Costa Rica, the government is now implementing a comprehensive strategy to achieve the optimal funding (the desired SEM approach) for their PA system (SINAC).

THE MULTIPLIER EFFECT OF NBT

Tourists visiting PAs spend on much more than entry fees and NBT experiences; they also pay for travel and local transport, accommodation, food, merchandise, and souvenirs inside and outside of the PA. Thus, tourists generate substantial revenue in a variety of sectors. For example, according to CONANP (2007), some 5.5 million tourists visited federal PAs in **Mexico** in 2006, it is estimated that they spent about \$286 million in and around PAs, corresponding to 2.3% of spending by international travelers visiting Mexico.

Like any sector, tourism creates a chain of economic activity that affects not only those delivering services directly to tourists and their employees, who earn more and consume more, but also their suppliers, and the suppliers to the suppliers. This long chain multiplies the initial amount spent by tourists.

According to the Bolivian Ministry of Planning and Development (2001), every dollar spent on cultural and nature tourism in **Bolivia** generates another \$1.2 in indirect benefits (Fleck 2006). This was the highest multiplier among a list that includes mining, oil and gas extraction, agrobiodiversity, and the sectors of forestry, hunting and fishing. The high multiplier of cultural and nature tourism in Bolivia

may be a result of the sector being relatively human resource-intensive, labor being a main input to produce the services delivered to tourists. Nature-based tourism (NBT) businesses have been flourishing in conjunction with PAs. NBT is particularly beneficial to small business including those in the informal service sector.

TABLE 10.8. TOURISM AS PERCENTAGE OF GDP AND EXPORTS IN SELECTED LAC COUNTRIES

COUNTRY	% OF GDP	% OF EXPORTS
BELIZE	14	31
JAMAICA	18	37
BARBADOS	28	51
BAHAMAS	35	60
MEXICO	1.4	4.6
GUATEMALA	2.7	13.8
BOLIVIA	1.9	11
PERU	1.7	11

FINANCING TO PAS

The effect of NBT on PA finance under BAU practices is extremely modest, leaving considerable financial gaps in these PA systems (e.g., Table 10.3). Initial estimates by TNC (2008) suggest that combined PA entry fees and tourism concessions make up about 11% of PA financing.⁵⁹ Tourism revenue to PAs is poorly diversified under BAU. This revenue is mostly based on rigid entry fees; concessions are the exception, not the rule. A key aspect of the transition to SEM is diversification of entry fees to provide options in terms of types of passes, service fees, points of sale, and forms of payment. Not all PAs have a tourism potential to exploit; some are too remote, lack infrastructure, or limit visitation to protect delicate ecosystems.

PRIVATE PAS

Private PAs (reserves) are becoming an increasingly important tool for conservation, mostly associated with transitions to SEM. In some cases, these reserves are part of the national PA systems (Colombia, Brazil, Costa Rica), and are becoming increasingly important to NBT. Nevertheless, unlike government-authorized and permanently-supported public parks, most private reserves are informally protected and lack sufficient area to protect megafauna or to avoid the adverse effects of fragmentation.

NEGATIVE IMPACTS OF TOURISM (BAU PRACTICES)

Despite the significant economic contribution of NBT, this form of tourism can also have potentially negative effects on PAs, if not man-

⁵⁹ Aggregated data from Bolivia, Brazil, Chile, Colombia, Ecuador (excluding the Galapagos), Peru and Venezuela.

aged well. In MPAs, for example, the International Ecotourism Society has documented degradation of coral reefs by cruise ship anchors and sewage, tourists breaking off chunks of coral, and commercial harvesting for sale to tourists (The International Ecotourism Society 2000). The transition from BAU to SEM is not primarily about increasing funding, but, rather, about improving management capacity and ecosystem preservation.

Tourism in PAs is concentrated in a few sites, while most PAs have few visitors. This skewed distribution is reflected in both the income generated and the impacts caused. There is evidence of natural resource depletion due to poorly-managed tourism operations in several national parks in LAC. For example, the number of tourists expanded from 40,000 to 140,000 in Ecuador's Galapagos National Park between 1990 and 2006. That expansion put more pressure on the islands' natural resources due to business development, migration from the mainland as more people are needed to support the growing tourism industry, visitor-mediated ecosystem disturbance, and an increase in non-native plant species on the islands. Consequently, UNESCO and IUCN have formally declared the Galapagos National Park to be "in danger" from these threats (Marine Protected areas News 2007). These issues could undermine the sizeable contribution of tourism in the Galapagos National Park to the Ecuadorian economy.

In the Eduardo Avaroa Reserve (EAR) in Bolivia, BAU is associated with inadequate management of NBT and a backlog of investments in tourist infrastructure. The PA, which is the most visited in Bolivia, faces issues of insufficient infrastructure, and weak personnel and management systems, all necessary to accommodate the growth in tourist numbers. Other problems are poorly-planned tourism operations and excessive, disorderly motor vehicle transit inside the reserve. Tourism, currently, threatens the conservation of biodiversity in this PA. Sustainable tourism management in EAR will result in \$800,000 in yearly revenue, up from \$160,000 in 2003 (Drumm 2007). Information on the cost of shifting from BAU to SEM practices in EAR is not available, but could easily be covered by the increased revenues.

NBT needs to be well-managed to minimize its negative impact on natural resources.⁶⁰ PAs should follow basic guidelines for sustainable tourism development (e.g., Rainforest Alliance) and need to plan better for NBT, starting with their management plans (Drumm 2008; Flores et al. 2008). Some PAs may need to restrict visitor numbers to match the carrying capacity of the setting. Further, it is critical that PAs receive sufficient funding for park operations, as well as for infrastructure investments needed for NBT.

60 "Sustainable tourism development meets the needs of present tourists and host regions while protecting and enhancing opportunity for the future. It is envisaged as leading to management of all resources in such a way that economic, social, and aesthetic needs can be fulfilled while maintaining cultural integrity, essential ecological processes, biological diversity, and life support systems" (WTO).

Human Settlements (Potable Water, Disaster Mitigation, Hydropower)

"The changes that have been made to ecosystems have contributed to substantial net gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many ecosystem services, increased risks of nonlinear changes, and the exacerbation of poverty for some groups of people. These problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems" (MEA 2005)

The LAC region's biodiversity hotspots are rich in endemic species, habitats, and ecosystems. These hotspots are particularly threatened by human activities. In 1995, more than 1.1 billion people, nearly 20% of the world population, were living within these hotspots, an area covering about 12% of Earth's terrestrial surface. This situation suggests that substantial human-induced environmental changes are likely to continue in the hotspots and that demographic change remains an important factor in preserving functioning ecosystems (Cincotta et al. 2000).

Human settlements benefit from PAs through the provision of a variety of critical services such as the provision of fresh water, regulation of natural hazards, and natural mitigation of climate change (see Box 10.3). These services are discussed next in the context of the BAU and SEM.

DRINKABLE WATER

Under a climate of growing water scarcity, access to clean, safe drinking water is a top priority. Forest and wetland PAs provide cheap, clean drinking water to countless rural and urban populations, including a third of the world's most populated cities (Dudley et al. 2010). Well-managed natural forests almost always provide higher quality water, with less sediment and fewer pollutants than water from other catchments (Aylward 2000). Research has shown that about a third (33 out of 105) of the world's largest cities obtain a significant portion of their drinking water directly from PAs (Dudley et al. 2010). This is evident in the LAC region (Table 10.9).

Latin America, as a whole, has one of the highest per capita volumes of fresh water in the world — about 3,000 m³/person/year. The destruction of water sources, combined with inequitable access, has left most Latin Americans "water poor," in the current BAU scenario. Millions live without access to clean water at all. While the region's available resources could provide each person with close to 3,000 m³ of water every year, the average resident has access to only 28.6 m³ /year. This compares to North America's annual average of 118 m³ and Europe's 64 m³ (Barlow and Clarke 2004).

Watershed conservation can greatly improve water quality and quantity, reducing water treatment costs. Tangible evidence is provided by the Chingaza National Park in Colombia, where the Bogota Water and

TABLE 10.9. EXAMPLES OF CITIES / METROPOLITAN REGIONS IN LAC DEPENDING ON WATER FROM PAs

CITY	PROTECTED AREA
BOGOTA, COLOMBIA	Chingaza National Park (50,374 ha)
CALI, COLOMBIA	Farallones de Cali National Park (150,000 ha)
MEDELLIN, COLOMBIA	Alto de San Miguel Recreational Park & Wildlife Refuge (721 ha)
BELO HORIZONTE, BRAZIL	Mutuca, Fechos, Rola-Moça & 7 other small PAs (17,000 ha)
BRASILIA, BRAZIL	Brasília National Park (28,000 ha)
RIO DE JANEIRO, BRAZIL	Tijuca National Park (3,200 ha) & 3 other parks in metropolitan area
SÃO PAULO, BRAZIL	Cantareira State Park (7,900 ha) & 4 other state parks
SALVADOR, BRAZIL	Lago de Pedra do Cavalo & Joanes/Ipitinga Environmental PAs
SANTO DOMINGO, DOMINICAN REPUBLIC	Madre de las Aguas Conservation Area with five PAs
QUITO, ECUADOR	Bioreserve El Cóndor (4 PAs): Cayambe-Coca Reserve, Antisana Ecological Reserve, Cotopaxi National Park, and Los Illinizas Reserve
CARACAS, VENEZUELA	Guatopo (122,464 ha), Macarao (15,000 ha), Avila (85,192 ha) National Park
MARACAIBO, VENEZUELA	Perija National Park (295,288 ha)

Aqueduct Company saved more than \$15 million in treatment costs in 2004 by investing in watershed improvement. **Colombia's** capital, Bogotá, gets up to 70% of its water from the Chingaza system, 50 km east of the city. Water from the Guatiquía, Blanco, and Teusacá rivers collect in two large reservoirs: the Chuza and San Rafael dams. The integrity and quality of this system largely depends on conservation of the watersheds of Chingaza National Park. Examples of how PA ecosystems provide fresh water for human consumption in Honduras, Venezuela, Ecuador, Brazil, Bolivia, and Chile are noted next.

In **Honduras**, the cloud forests of La Tigra National Park (23,871 ha) provide over 40% of the annual water supply to the 850,000 people of Tegucigalpa (WWF-running pure).

Most of **Venezuela's** fresh water comes from superficial sources (MINAMB/Fundambiente 2006). Cartaya and Pabón (2009) note that 33 of 43 National Parks protect important water sources that regulate soils and water run-off. Guatopo National Park supplies water to Caracas. Parks in the central western region provide water to agro-industry in the high western Llanos and the Valley of Quibor, in addition to supplying water to Barquisimeto and other cities nearby. Furthermore, in the Guayana region, national parks protect the sources of large rivers such as the Orinoco, Caura, and Caroní, which provide fresh water to cities such as Guayana and Bolívar. An-

dean PAs protect the rivers that supply drinking water to the region's main towns, as well as water for irrigation of Venezuela's largest horticultural production area.

Conservation of mountain-forest ecosystems can be the cheapest way of maintaining high quality water (the SEM scenario). The 1.5 million inhabitants of **Ecuador's** capital, Quito, derive 100% of their water from Andean creeks and rivers originating in the Condor Bioreserve; 80% is derived from two PAs. The Bioreserve is a mosaic of PAs, farms, and indigenous territories, encompassing cloud forests, high altitude grasslands, rainforests, and innumerable creeks, lagoons, and rivers. To safeguard the fresh water that Quito depends on, the price of water service was reviewed to include the cost of watershed conservation (SEM). The FONAG water fund is being capitalized through a percentage of the water fees. It now produces \$1 million yearly for conservation and community development projects in the watersheds (TNC 2008).

In **Brazil**, an interesting concept for pricing water has been developed by the Conservation Strategy Fund (CSF) in the Guapi-Macacu watershed (State Park Três Picos) near Rio de Janeiro.⁶¹ The study estimates the protection costs of water resources in the park at about \$318,000 — including land tenure disputes, guard salaries, a mix of training, equipment, fuel, and administrative costs, and other selected infrastructure needs. The cost of park protection adds only 1.18%, on average, to the rates currently paid. The average annual cost / person for headwaters protection is around 35 cents (US). Thus, if political will is available to move to sustainable water fees (the SEM scenario), at almost negligible individual costs, water users can secure their water supply, while simultaneously protect the ecological integrity of the TPSP (Strobel et al. 2007).

Water from PAs in **Bolivia** is an important ecosystem service. Prime examples are the Piraí River from the Amboró National Park, and the Tolomosa and Victoria rivers from the Sama Reserve and the Tunari National Park. The Piraí River receives 50% of its flow from Amboró and supports agro-industry in the middle watershed valued at \$500 million per year. In Sama, 50% of the drinking water for the city of Tarija is provided by ecosystems of the Sama Reserve, which also provides 80% of the water supply for the San Jacinto system, which generates 25% of the electricity consumed in Tarija. Without adequate protection of the ecosystems of Sama, a decrease in water supply for the hydroelectric system under the BAU scenario may result in an annual loss on the order of \$230,000. The forest ecosystems of the Tunari National Park supply fresh water to over a million people, most in the nearby city of Cochabamba. However, in all these PAs mentioned, management is below basic needs; this con-

⁶¹ The Strobel et al. (2007) study covers 5 key aspects: (1) estimating the cost of guaranteeing the hydrological protection afforded by the park, (2) estimating the park's contribution to water used by the main consumer, (3) defining the economic criteria relevant to the allocation of protection costs among consumers, (4) posing a proposal of three alternative pricing scenarios, and (5) developing a description of an institutional arrangement to govern the payment system.

dition can be considered to be BAU. All three PAs have large financial deficits; the resources provided by the government hardly cover 30% of the cost to adequately manage them. The PROMETA study notes that SEM is achievable in Sama, if for instance, the inhabitants of Tarija contribute \$15/year, with an in-kind labor contribution by the rural population in the area (Escobar et al. 2009).

In **Chile**, a recent study (Figueroa 2008) notes that the fresh water service provided by the Valdivia forest (a defined Biodiversity Hotspot) consisting of 2,418,361 hectares was estimated at \$16.4 m. It was also estimated that Valdivia's forest has a potential to benefit over 7 million people (1,984,280 families) in the area, including the population of the city of Valdivia and other communities settled in a ratio of 40 km around the PA. The study used \$8.2 willingness value (Nunez 2006 in Figueroa 2009). Assuming that the Valdivia Protected Area is in SEM (depending on funding, level of threats, and management), the protected area is safeguarding ecosystems that represent a significant value to the local and national economy of Chile.

DISASTER MITIGATION AND PREVENTION

PA ecosystems retard run-off, slow flooding, reduce landslides, mitigate climate change, and help control pest outbreaks. Evidence regarding the potential avoided cost of infrastructure reconstruction or safety net rehabilitation resulting from the establishment, expansion, or consolidation of PAs is unavailable. Nevertheless, this strategic service is being recognized. For example, in Mexico, PAs have been established in four of the five regions most vulnerable to climate change effects (Bezaury 2009).

HYDROPOWER

Sedimentation and lack of water for hydropower is becoming a problem worldwide; PAs managed under SEM are part of the response to such threats, which also affect irrigated agriculture and potable water supplies. Water scarcity is now evident in the Andes, the Himalayas, and the Alps. Neither the economic effect of water shortages on hydropower output, nor its potential reversibility as BAU practices give way to SEM, have been quantified. Nevertheless, the transition from BAU to SEM, including PA management, is part of the solution; the transition makes sense in economic, social, and environmental terms. This point about PAs and hydropower is illustrated with examples from Peru, Venezuela, Mexico, and Costa Rica.

In **Peru**, approximately 61% of hydroelectricity is produced in eight plants using water from as many PAs, such as the Junin Reserve, which provides water to the Interconnected Hydroelectric Systems of Mantaro. All together, these eight PAs, currently under BAU, enable the production of 10.6 GW/hour with an estimated annual value of about \$320.5 million (León 2007).

Cartaya and Pabón (2009) note that **Venezuela's** hydropower potential is equivalent to the energy of 2.5 million barrels of oil per day (MPD 2005). About 73% of electricity generated in 2007 came from hydropower plants with catchments in national parks (EDELCA 2008). Maintaining BAU practices will eventually result in more significant water shortages and loss of hydropower. The government may potentially lose the estimated annual savings of \$15 billion, the equivalent of 23% of the 2007 budget, excluding the cost of environmental impact prevention measures (Ministry of Energy and Oil 2009). The most important case is the Guri Dam at the Caroní River, the largest hydropower system in Venezuela, with an estimated potential of 25 GW. According to EDELCA (2004), the Caroní River that is part of National Park Canaima provides one third of the water of the Guri Dam. Without the protection afforded by this park, the value of hydropower production and the useful life of the dam would be significantly reduced.

In **Mexico**, a recent multi-sector estimate of the value of water from PAs commissioned by CONAGUA (National Commission for Water) assessed the economic value of water in relation to PAs. The study clarified the value of additional water provision from PAs for irrigation, hydropower, and municipal (domestic) use. It estimated the total value of additional water for municipal supply, irrigation, and hydropower is \$293 million, shown in Table 10.10.

In terms of BAU and SEM, this study concluded that municipalities with relatively well-funded and well-managed PAs (SEM) have a significant advantage compared to those without PAs (BAU). Municipalities with PAs are 6.8% above the average water availability in aquifers, 7% above the average water availability for different municipal uses, and 5% above the average water availability for hydropower generation. Based on the current low water prices (BAU price), the annual value of the additional water provided by PAs to Mexican economy represents about \$293 million.

Finally, in **Costa Rica**, transitions from BAU to SEM have resulted in more forest conservation and declining hydropower costs. Hydroelectric utilities are funding reforestation upstream of their plants to maintain regularity and quality of water supply (SEM). PES are made by power companies to villagers to maintain forest through an NGO, with additional funds coming from the government (World Bank/WWF 2003).

10.5 IMPORTANCE OF PROTECTED AREAS TO EQUITY AND POVERTY REDUCTION

PAs, primarily set up to conserve biodiversity, are now increasingly under pressure to deliver benefits to people and contribute to sustainable development by helping to improve equity and reduce pov-

TABLE 10.10. VALUES OF SELECTED WATER USES IN MEXICO

SELECTED WATER USES IN MEXICO	TOTAL VALUE (MILLION OF MEX\$)	PA RELATED VALUE (MILLION OF MEX\$)	PA RELATED VALUE (MILLION OF US\$, EXCHANGE RATE 13:1)
ADDITIONAL WATER, MUNICIPAL PUBLIC SUPPLY ¹	22,890	2,034	151
ADDITIONAL WATER FOR IRRIGATION AGRICULTURE ²	12,711	889	66
ADDITIONAL WATER FOR HYDROPOWER ³	20,648	1,032	76
TOTAL	56,249	3,955	293

Source: Bezaury and Pabón 2009.

Note: Municipal water consumption (2006) and electricity (2007), 2009 Mex\$.

1 National Water Commission - CONAGUA. 2007. *Water Statistics in Mexico*. Mexico City. 260 pp. + 1 CD.

2 Galindo L. M. In prep. *The Economics of Climate Change in Mexico*. Consultancy Report, SHCP, SEMARNAT, and British Embassy. Internal document.

3 Department of Energy. 2008. *Basic information 1995-2008: Commodities on electricity internal sales*. <http://www.energia.gob.mx/webSener/portal/index.jsp?id=71>

erty. According to the CBD, “much of the evidence illustrating the association between poverty reduction and PAs remains anecdotal ... there are many instances where the right types of PAs, when combined with the appropriate governance systems, have contributed — sometimes considerably — to the well being of the people who live in and around them (Secretariat of the Convention on Biological Diversity 2008).

In this report and chapter, equity is understood as the degree to which all people have access to economic, social, and political opportunities, and specifically to the distribution of costs and benefits between rich and poor. PAs may contribute to economic, political, and social equity. However, this desired condition is not always the case (see Box 10.4).

The influence of PAs on equity and poverty alleviation comes on two levels: locally, in the communities within or near to PAs, and, broadly, in the society at large. Engagement of nearby communities and other stakeholders is essential under SEM to assure that externalities are taken into account and that all affected parties are integrated into the planning and implementation process that can ensure a sustainable outcome. The integrated, participatory approaches typical of SEM are structured to develop equitable solutions; actions conducive to poverty alleviation generally emerge.

Assessing the effects of PAs on poverty is complex, requiring attention to a range of factors related to rural populations like income, livelihood security, access to infrastructure and markets, education, empowerment, gender, health, and access to natural resources. These factors exceed the scope of this section, which will focus on benefits from compensation for forest conservation (a kind of PES scheme), reduction of deforestation and degradation (REDD and REDD+), NTFP, and transfers from taxes. Income and job creation from tourism in PAs are discussed in Section 3.4. Selected

evidence is presented on potential negative impacts on equity of limited or unequal distribution of benefits and costs of PAs.

Economic Benefits

PAs provide a range of services that increase access by local people to income-generating opportunities. This is particularly true of multi-use reserves primarily designed to protect people’s access rights to resources and representing approximately 90% of terrestrial PAs (WCS 2007). There is limited evidence on actual outcomes in terms of attaining equity, conservation, and development goals. Two examples follow.

Payments for environmental services (PES): The Bolsa Floresta program in **Brazil**, conceived in the context of “Deep Amazon” populations, compensates indigenous people for conserving the forest. There are four components: (1) the Bolsa Floresta Familiar provides monthly payments of \$22 to female-headed households that reside in PAs and commit to stop deforesting, (2) the Bolsa Floresta Asso-

BOX 10.4. PAs and Poverty Reduction

Adam et al. (2010) assessed the effect of PA systems on poverty in Costa Rica and Thailand (both shifting to SEM). In 2000, average poverty rates were higher near PAs in both countries, suggesting that PAs may have exacerbated poverty. However, analysis using methods to control for confounding factors indicated that despite the differences in Costa Rica’s and Thailand’s institutions, economic development trends, and PA system histories, there was no evidence that their PA systems have exacerbated poverty on balance in neighboring communities.

This conclusion does not imply that all segments, sub-districts, or poor households experienced poverty alleviation from PAs. The study measured the impact of PAs over decades; thus short-term effects vary. The poverty measures used do not represent all dimensions of social welfare. The study did not assess the ways in which PAs may have helped reduce poverty. Finally, Costa Rica and Thailand are not representative of all developing nations since both have experienced rapid economic growth, enjoy stable political systems, make substantial investments in their PA systems, and have strong eco-tourism.

cição strengthens community associations within State PAs, funded at 10% of the amounts dedicated to female headed families, (3) the Bolsa Floresta Renda, which provides on average US \$1,740/ community/ year (communities average 11 families), and (4) the Bolsa Floresta Social, which grants an average of US \$1,740/ community/year to cover improvements in education, health, communications, and transportation, as well as basic support for local forest guards. Bolsa Floresta began in 2008 with 4,244 families registered, of which 2,702 were eligible for the Bolsa Floresta Familiar (Viana 2008). This program is thought to increase equity by channeling PES funds to the neediest communities and households, but no evaluation of outcomes is yet available.

Non-timber forest products (NTFP): Though often overlooked, NTFP are a dependable source of food and income in rural areas that can have substantial economic value and foreign exchange earnings. International trade in some NTFP generates large returns for resource harvesters as well as others within the commodity chain. While difficult to establish firmly, the global value of international trade from NTFP has been estimated at \$11 billion/year (FAO 2007). But, this benefit is seldom equitably distributed; rural communities in LAC usually receive only marginal benefits (yet, important to them). Examples of NTFP are widespread in LAC. However, with few exceptions, such as natural rubber in Brazil, and brazil nut in Bolivia and Brazil, benefits are low and, in many cases, based on short-term projects funded by international donors. This situation can be explained partly by limited domestic investment in NTFP and the resulting absence of national-level strategies to address opportunities and develop markets.

In the LAC region, PAs commonly overlap with indigenous and settler communities. In such cases, they can contribute not only to protection of forest that otherwise would be depleted, but also to income-generating programs based on sustainable NTFP use. The following examples illustrate the benefits from NTFP in PAs (adopting SEM practices) to local communities in Peru, Bolivia, and Brazil.

In **Peru**, the average value of harvested NTFP per household in rural Amazon communities was \$1,658/year, some 57% of household income. Agricultural income averaged \$1,169 (Gram et al. 2001).

In **Bolivia**, PAs generate an estimated total economic value of \$387,228 (excluding tourism) in 19 NTFP projects in several municipalities (Escobar et al. 2009). The PA projects included farmed caiman skin in TIPNIS and Madidi; brazil nuts in Manuripi; organic honey in Tariquía, Amboro, and Pilón Lajas; and organic coffee in

TABLE 10.11. EXAMPLES OF NTFP IN THE LAC REGION

COUNTRY	NTFP
PERU	In Manglares de Tumbes, NTFP generate \$2.7 million / year to the local economy. NTFP in the tropical lowlands in the Peruvian Amazon are valued at \$13/ha as contribution to the local economy. The total value of NTFP in the entire Peruvian Amazon has been estimated at \$698 / ha.
ECUADOR	Average annual value of wild species use in the Ecuadorian Amazon is estimated at \$120/ha. Net value of the extraction of NTFP in Northern Napo is estimated at \$1,250 to 2,580 / family / year.
VENEZUELA	Annual value of wild foods consumed in Venezuelan Amazon ranges from \$1,902-\$4,696 / family.
PANAMA	The estimated annual value of diverse NTFP harvests in the Coiba National Park is \$1,480,000.

Source: León 2007

Madidi and Pilón Lajas. All these PAs are home to indigenous peoples. At least nine of the projects reviewed in this study involve and benefit 2,500 households, which include approximately 100 rural communities in PAs. In-depth studies of regional socio-economic outcomes have yet to be done.

In **Brazil**, extractive reserves have been seen as a controversial alternative to deforestation since their creation. By 2002, there were 16 extractive reserves encompassing 3.4 million ha with a population of 28,000. By 2010, the number of extractive reserves had almost doubled. NTFP in the Amazon generate 10% to 20% of regional income. Rubber⁶² is still the leading NTFP in extractive reserves; 65% of the NTFP are subsistence components.⁶³ In general, NTFP contribute to economic equity around PAs, since most producers and beneficiaries are rural settlers and indigenous peoples on the low end of the socio-economic spectrum. Further examples of the value of NTFPs appear in Table 10.11; additional information on income-related benefits from PAs in LAC, compiled by the WWF, is found in Annex 10.4.

Transfers from taxes: PAs can generate, in some cases, important revenue for local governments from tax transfers. Such income can be directed to pro-poor investments and PA transitions from BAU to SEM. In **Brazil**, the Constitution mandates transfer of 25% of the revenue from the ICMS sales tax from State to local governments. Paraná State introduced an ecological criterion for the ICMS in 1992, later followed by 13 other States (half of the total). A new ICMS distribution system earmarked 2.5% of the total ICMS for allocation to municipal governments with watershed PAs and a similar amount for those with other PAs. These provisions act as incentives to create PAs and fund pro-poor programs (Grieg-Gran 2000).

Evidence from Rondônia and Minas Gerais provided by Grieg-Gran

62 Natural rubber extraction is still subsidized by the government with minimum prices above the market. Planted natural rubber is much cheaper. UNDP Brazil is currently launching a program to establish minimum prices for extracted products.

63 Deforestation Alternative: Extractive Reserves & NTFP. Presentation by Caitlin Everett and Tamara Mitchell et al. (2002).

(2000) indicates that the Ecological ICMS has potential to create incentives for conservation in counties with low average levels of value added and primary production. For example, in eleven counties in Rondônia, the value added and primary production of an area of land of 1,000 hectares would have to be at least 50 times greater than the current average, to generate more ICMS revenue by other mechanisms than establishing a PA. However, PA creation may not be financially attractive for all countries and states, particularly those that are economically better off, due to trade-offs among the different ways of accessing ICMS allocations (Grieg-Gran 2000). The Ecological ICMS works as an incentive to create PAs and increase revenue, but the transition from BAU to SEM can be accelerated if part of the ICMS transfers is used to improve management of existing PAs.

Political and Social Benefits

PAs can be associated with the empowerment of some of the most vulnerable members of society, in particular rural women, indigenous peoples, and marginalized rural communities. Involving stakeholders from all socio-economic levels makes for much more sustainable PA funding, governance, and management than do purely top-down arrangements.

Across LAC, women's participation in local organizations and projects has improved since PAs were established and community organizations involved in PA co-management. This situation can be beneficial to the individual, her household, and the community as a whole; employment of women, in comparison to employment of men alone, has tended to contribute more to economic and social development.

There is evidence across the region that as a result of participation in PA-related activities, women have better access to cash, jobs, property, and freedom of movement, as a result of PAs being established. This can lead to a positive impact because girls are more likely to be sent to school, women can work outside the home, wages are more similar to those of men, and, thus, women are less economically dependent. Also, they are more likely to take part in decision making within and outside the household. Indigenous peoples can be similarly empowered. Marginalized rural communities are often involved. These effects can be seen in cases from Bolivia and Ecuador.

Bolivia is a good example. After the establishment of Madidi National Park (NPM), with support of park authorities and international NGOs, various levels of community organizations emerged to participate in park management, and in several integrated conservation and sustainable development projects in the park and its buffer zone. In the eastern part of the park, these organizations were the NPM Management Committee, water management associations, local women's associations, and NTFP producer associations. These groups worked with 21 communities settled in the park's eastern buf-

BOX 10.5. Empowerment

The Galapagos Co-management Institution consists of a tripartite arrangement uniting a local Participatory Management Board (PMB), an Inter-institutional Management Authority (IMA), and the Galapagos National Park (GNP). The PMB is made up of the primary local stakeholders while the IMA represents Ministers and local stakeholders.

PMB members present specific management proposals (e.g., concerning fisheries and tourism regulation), which are analyzed, negotiated, and decided by consensus. The consensus-based proposals are channeled for approval to the IMA and then to the GNP for implementation and control.

fer zone near the towns of Rurrenabaque, San Buenaventura, Tumupasa, and Ixiamas, promoting active participation of local women and youth. In addition, establishing the park promoted the strengthening and active participation of existing indigenous communities (e.g., Tacana people from Tumupasa) and many settler communities in decision making on natural resources management. These better-organized local entities were able to dialogue more effectively with local government regarding allocation of funds for 1997-99. During this period, the NPM was severely under-funded. Park employees barely managed to get paid, with months' delay. If sufficient funding had been available, the effects of the park's community-strengthening programs would have been much broader.⁶⁴ Nevertheless, the Indigenous Council of the Tacana People (CIPTA) raised its capacity to negotiate and improve projects with international donors operating in the area (e.g., GTZ and SNV) and to access funding administered by the local governments under the new Popular Participation Law.

In **Ecuador**, co-management of Galapagos National Park is another example. The park contains remarkable terrestrial and marine ecosystems and became, some years ago, the site of complex — at times — violent multi-stakeholder conflicts. Rapid economic and demographic change, the presence of unregulated industrial fishing, the emergence of high-value fisheries for Asian markets, state-imposed policy and regulations, and general non-compliance with the management plan of the Marine Reserve were all factors fueling those conflicts (BAU practices). In 1998, Ecuador passed legislation that introduced migration control within the country, created one of the world's largest marine reserves (130,000 km²), prohibited industrial fishing, and established an institutional framework for participatory management. The creation of the Galapagos Marine Reserve was the fruit of a participatory planning process that produced the Park's management plan (Borrini-Feyerabend 2004 adapted from Heylings and Bravo

⁶⁴ Experience of the Manager of the Madidi Conservation and Development Program, funded and implemented by CARE Denmark/Bolivia, 1977-1999. Flores, M, 2009.

2001). However, the participatory management plan has not been able to eliminate the violent stakeholder conflicts that persist to date, reflecting powerful economic and political interests (see Box 10.5).

Are PA Objectives Compatible with Poverty Reduction?

Many consider that the contribution of PAs to improve income in rural communities is an important element of poverty alleviation. Sustainable income generating opportunities with PES, NBT, and access to NTFP are among the mechanisms. But, comprehensive, in-depth assessment of the overall effects of PAs on income generation and distribution is lacking; the more limited studies available are promising but may compose a favorably biased sample.

In a recent global study of the contribution of PAs to poverty reduction, Dudley et al. (2008) reviewed different levels of linkage between PAs and the rural poor (WWF 2008). No linkage refers to protection as the core aspect; people are viewed as a threat. This scenario can be considered BAU. Indirect linkage takes into account the socio-economic development of people living around PAs. In direct linkage, people's livelihoods are recognized as being dependent on conservation. The direct linkage case can be considered SEM (indirect linkage would have to be seen case-by-case). Despite difficulty in showing that conservation and poverty reduction can be achieved simultaneously in specific PAs (direct linkage), the study provides clear evidence of the role of PAs in improving income, livelihoods, and, thus, well being. However, the study also notes that, in some cases, the creation of PAs has deepened poverty. The authors note that, while PAs are not a tool *per se*, they can deliver economic benefits under certain circumstances (Dudley et al. 2008).

Payments for ecosystem services (PES) may reduce poverty by making payments to rural poor populations, often those in upper watersheds. The extent of this poverty reduction depends on how many PES participants are, in fact, poor. Further, poverty reduction through PES relies also on poor people's ability to participate and on the amounts paid. Although PES programs are not designed for poverty reduction, there can be important synergies when program design is well thought out and local conditions are favorable. Possible adverse effects can occur where property rights are insecure or if PES programs encourage non labor-intensive practices (Pagiola et al. 2005).

The impact of PES programs is not necessarily positive, however. Two main concerns have been expressed. Landell-Mills and Porras (2002) warn that by increasing the value of currently marginal land, PES programs could increase the incentive for powerful groups to take control of these lands. This land grab might exacerbate conflict in situations where tenure is insecure and exclude the most vulnerable from the benefits of PES. A different concern is voiced by Kerr

(2002): livelihoods of the landless poor — women, herders, and others who are non-participants in PES programs and who often depend on gathering NTFP from forests — may be harmed if PES conditions limit their access to forested land.

Tourism in PAs can generate or reinforce inequality in distribution of benefits, partly due to BAU practices. In **Belize**, the economic value and benefits of the multi-use Gladden Spit and Silk Cays Marine reserve (GSSCMR) were unknown. Besides tourists (international and domestic), a range of stakeholders benefit: communities, local fishers, and tour operators, all of whom enjoy increased income from employment and business opportunities. A recent study measured the net value (NV) of the benefits accruing to each group and provided an aggregate net annual value and a 25-year projection: \$1.3 million and \$13 million-\$29 million, respectively (depending on the scenario and discount rate). The inclusion of non-use values increased the NV to \$41 million-\$93 million. In terms of distribution of economic benefits, it was estimated that international tour operators receive 71% and international hotel owners 5%, while Belizeans in local communities receive 24% of the total value measured (15.5% to the residents and 8.5% to fishers from the north of the country). This is a relative low percentage, especially since it is shared by a large number of people: 1,200 are estimated to split these benefits even though many communities are excluded from the benefit pool. It is assumed that local governments in the region enjoy significant tax revenue from income tax, sales tax (VAT), property tax, licensing, and concessions fees (Hargreaves-Allen 2009).

The evidence of localized PA-based ES presented in the previous sections — e.g., water, fisheries, NTFP, NBT — supports the assertion that the contribution of PAs to improve income in rural communities is an important element of poverty alleviation. However, in terms of opportunity costs — people may benefit from conservation, but do they give up more to get those benefits? — the question remains open. The examples reviewed by Papageougiou (2008) and Balmford (2002, 2004), Pet-Soede, Portela, Adam and others suggest not. Other studies are less encouraging about a positive connection between PAs and poverty reduction.

A different perspective is offered by Quintero et al. (2009), in a study of Andean watersheds at Moyobamba (Peru); this work serves to examine the effects of introducing PES schemes and PAs on conservation and poverty reduction. The town of Moyobamba (40,000 people) gets drinking water from the Rumiyacu and Mishquiyacu micro-watersheds; 61% of the area is still covered with native forest. Yet, the annual deforestation rate in the area is a staggering 4.2%. Most farm land is untitled and 42% of farmers cultivate coffee; productivity is low. The replacement of native vegetation by other land uses led to a 20% rise in drinking-water treatment costs. As a result, the Municipality declared the watersheds a Conservation Area. Switching to shade-grown coffee would significantly increase farmer economic benefits: introducing shade-grown coffee would require large

initial investments, but could increase net present value (NPV) by 91%, compared to the traditional slash-and-burn practice. This high initial investment may be provided by urban water-users of Moyobamba. In contrast, tree plantations and living fences would reduce NPV by 62% and 11%, respectively, if farmers are not compensated.

This case makes clear that the question of whether PAs and poverty reduction are compatible depends on the way each component is carried forth. If poverty reduction includes protecting the income of farmers in BAU enterprises on lands they do not own via PES payments sufficient to support conversion to shade-grown coffee; then, yes, PAs and poverty reduction can be compatible. The issue, thus, is fundamentally a political one — whether to end BAU externalized costs, by what means, and at the expense of whom? In LAC, under BAU, solutions have most often been reached at the expense of the less prosperous, more disenfranchised communities of people.

Thus, in a few places where benefits and costs are thoroughly reviewed and addressed, it appears that PAs can make a contribution to poverty alleviation, in at least some cases, if political will to do so is incorporated into their governance and management. Whether the relatively localized evidence on this would hold for cases in other LAC countries remains an open question.

10.6 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Despite gaps in the data, the existing evidence on the economic value of the ecosystems services (ES) provided by PAs is compelling. Overall, PAs raise productivity in agriculture, fisheries, forestry, hydropower, and nature-based tourism (NBT), among other sectors. Further sector-based research is needed to quantify the economic benefits derived from PAs, including job creation, income, local and national tax revenues, and the role of PAs as drivers of foreign exchange earnings and investment —and on how these benefits are distributed. Meanwhile, on a general level, the evidence reviewed permits a number of conclusions.

THE TRANSITION FROM BAU TO SEM IS FEASIBLE.

Transitioning from BAU to SEM in PA management is affordable. BAU approaches have hidden costs in many of the reviewed cases (e.g., cases where BAU land use resulted in erosion in PAs and ultimately burdened downstream water users with high costs of sediment removal). Based on a broader conception of costs and benefits, SEM approaches can often be self-sustaining (as when funds saved from water treatment are used to prevent sedimentation). Thus, the

shift from BAU to SEM practices can make economic sense. Some of the conclusions that follow illustrate the higher costs of BAU that justify accelerating the transition to SEM, though that transition process will require that appropriate, permanent resources be allocated to PAs to cover financial gaps (Section 1.2). This condition can be achieved if there is political will to increase PA budgets, diversify income sources, provide financial autonomy, and to introduce PA-oriented fiscal reform. Even so, SEM approaches will require that PA management entities address their capacity gaps related to cost efficiency, transparency, and accountability.

BARRIERS TO THE TRANSITION FROM BAU TO SEM FOR PAS ARE SIGNIFICANT.

Politicians, in the past, have seldom opposed creation of PAs in remote places where opportunity costs are low, especially when supported by international seed money. Creation of new PAs, however, is becoming more difficult as pressure increases on governments to deliver tangible economic and social benefits. Transferring funds from development to conservation becomes unattractive for policy makers in LAC countries.

Resource degradation under BAU, typically, offers immediate returns in the form of marketable products, tax revenues, or subsistence goods, among others. With its long-term perspective, SEM is often less easily exploited in the short term. The impact of ecosystem wear and tear under BAU practices may not be visible in the short run; for instance, extinction of species is the result of decades of accumulated neglect. Those actors focused on short-term gains can often “get away” with not addressing critical SEM priorities, despite damage to ecosystem functions.

There is often a play of interests around the tighter regulation of natural resource exploitation under SEM, as some BAU stakeholders see their access eroded (e.g., loggers) and others, better adapted to work under sustainable conditions, gain influence and access (e.g., sustainable tour operators). Limited participation of the private sector in SEM for PAs is a critical barrier that may require attention.

Lack of reliable financial and economic data to assess the economic benefits of PAs in most countries is another barrier. This information is indispensable in establishing effective dialogue with decision makers.

Forested PAs provide opportunities, though sustainable forest management (a SEM approach), to generate income from concessions, fees and taxes, and PES.

Concessions for controlled harvesting of timber or NTFP or for attending tourism; and collection of user fees and taxes on enterprise earnings; and generating income flows from PES for watershed protection, carbon sequestration, and other ES: these activities could make many PAs into self-sustaining revenue centers. Gaps in the legal and regulatory frameworks, obsolete fee and tax systems, and

lack of integrated management under BAU means that these potential revenue streams remains largely untapped, representing a sizeable opportunity cost.

GROWING BIODIVERSITY AND ECOSYSTEMS MARKETS CAN PROVIDE SIGNIFICANT BENEFITS TO BUSINESS.

PAs supply ES that promote economic growth. The review work to develop this chapter found no data to suggest that investing in PAs (shift to SEM) is not a sound economic choice. PAs managed under BAU and SEM approaches contribute directly to economic growth and equity in the sectors covered: agriculture, fisheries, forests, hydrological resources, and NBT — as among other economic sectors. PAs contribute to productivity, jobs, tax revenues, and foreign exchange amounts. Healthy ecosystems and biodiversity in PAs help reduce operating costs in critical sectors such as water supply and hydropower, and help avoid the cost of disasters.

NBT businesses have been flourishing in conjunction with PAs. The Caribbean, Costa Rica, Guatemala, Panama, Peru, Ecuador, and Bolivia are good examples of countries where important economic benefits come from NBT. For instance, PAs in Peru generated an estimated \$146 million of tourism-related economic activity in 2005. NBT is particularly beneficial to small business, including those in the informal service sector.

Agriculture and forestry have benefited from PAs. Many PAs, globally, are closely linked to agriculture. For example, a Cambodian rice project received a certification to market wildlife-friendly “Ibis Rice” (www.wscambodia.org/conservation-challenges/communities-and-livelihoods/wildlife-friendly-products.html, accessed July 2010). The project provides communities with an incentive to engage in conservation by offering farmers a premium price for their rice if they agree to use wildlife-friendly farming techniques. These conservation agreements protect the rare water birds and other species that use the areas where the rice is grown.

LAC coffee plantations benefit from pollination services from forests in Costa Rica, Guatemala, Colombia, and other countries in the region. In Brazil, FONAs — a type of PA where forestry is permitted under appropriate management conditions — also illustrate the timber-based business potential of PAs. Likewise, water quality and water tariffs that include the cost of watershed protection are growing markets and business opportunities.

To date, biodiversity conservation is still seen, by many business, as a risk or liability. Traditionally, company business plans have focused on keeping the company in business (and barely complying with environmental standards), rather than focusing on developing and incorporating ecosystem-friendly business models that can increase revenue. In the past decade, as a result of the climate change debate

and the global financial crisis, more firms are exploring biodiversity and ecosystem-friendly operational models. The success of the initial modest investments in SEM-based ventures will lead to continued growth, surpassing the market average, as has been seen in the renewable energy and ecotourism fields.

PAS DRIVE FOREIGN EXCHANGE EARNINGS AND LOCAL EMPLOYMENT, ESPECIALLY VIA TOURISM.

The role of PAs in NBT and in the tourism sector as a whole is now well established. Studies in Costa Rica, Venezuela, Ecuador, Peru, and Chile provide solid evidence of the link between PAs and the economic benefits of tourism. PAs provide continuous habitats with views, biota, exotic foods, fresh air and water, and cultural services, without which NBT would scarcely be possible.

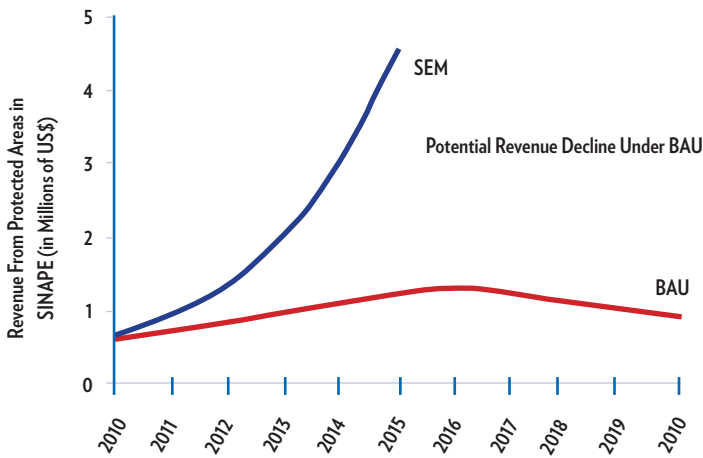
Tourism is a principle foreign exchange earner for LAC countries. This economic boon is more visible on small islands where there is a solid base of NBT. In Jamaica, Barbados, and the Bahamas, tourism accounts for 18%-35% of GDP and 37%-60% of exports. A recent study of 138 Caribbean PAs found that marine PAs (MPA) increase diving tourism in the region. In larger countries with more diversified economies, the contribution of NBT is lower but significant. In Bolivia, a total of 82,770 foreigners visited PAs (16% of foreign visitors) in 2007, when tourism netted about \$292 million in foreign exchange.

Section 3.4 shows the creation of local job and business opportunities by NBT in and around PAs. In many places, NBT jobs have transformed economic backwaters into vibrant local economies. However, these service sector jobs can be low paid, seasonal, and localized, especially under BAU approaches to tourism.

With few exceptions, tourism in PAs is still poorly managed in the LAC region. This is alarming because BAU practices can seriously harm major tourism-rich PAs. For example, in Ecuador’s Galapagos National Park, tourist numbers have expanded from 40,000 visitors in 1990 to 140,000 in 2006, putting great pressure on the natural resources. UNESCO and IUCN have formally declared the Galapagos National Park to be “in danger” from this tourism volume-based threat. The private tourism industry in the park contributes little to finance park management and has resisted implementation of a consensus master plan.

Studies show that introduction of sustainable tourism management in PAs can boost in revenues. For example, four national parks in Peru (Huascarán, Paracas, Tambopata, and Titicaca), currently under BAU practices, generate some \$600,000 annually. If there is no shift to SEM, that figure may rise to \$1.2 million, with a high potential to decline due to wear and tear. With a shift to SEM, however, revenue could increase to \$4.3 million annually in five years (León 2010). This is illustrated in Figure 10.4.

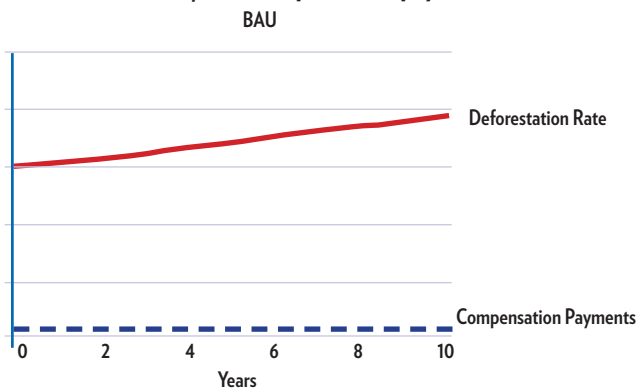
Figure 10.4. Potential growth of tourism revenue from PAs under BAU and SEM in Peru.



THE BENEFITS OF PAS ARE NOT EQUALLY DISTRIBUTED.

PAs under SEM can facilitate more sustainable and equitable natural resource management, as in the case of indigenous PAs in Brazil. Indigenous and rural people living in and around PAs have often been isolated or only partly incorporated into economic activities. These populations have low incomes and limited access to basic services. PA creation under BAU may exacerbate poverty as a result of opportunity costs (at local government and individual levels) and partial loss of access to natural resources (e.g., firewood, game, building materials). In the case of PA systems in transition to SEM, a study of their impact on poverty in Costa Rica and Thailand concluded that there was no evidence that they had exacerbated poverty in neighboring communities (Adam et al. 2010). Furthermore, no evidence has been found of human settlements in and around PAs having experienced major loss of access to natural resources; nor did this study find evidence that creation of PAs increases marginalization and poverty of rural communities on balance, though some individuals or groups may lose, while others gain.

Figure 10.5. BAU vs SEM: deforestation without / with compensation payments



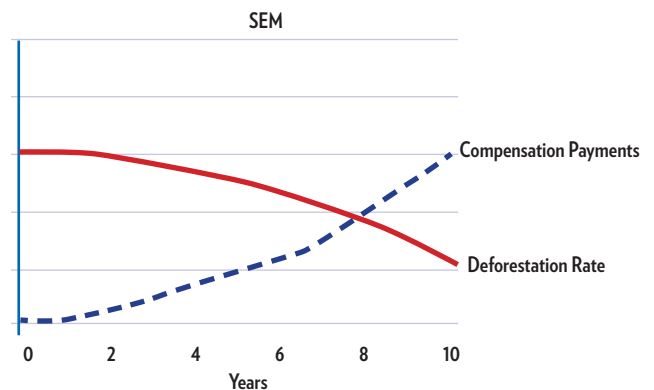
Much evidence shows that PAs generate benefits to local people, particularly when they are able to access mechanisms to receive PA benefits like participation in programs related to sustainable use of biodiversity resources, PA management (patrolling), or NBT. However, in some cases, PA benefits have not been evenly available to local residents. Thus, there are winners and losers. The losers, whose economic situation may worsen after the establishment of PAs, lack access to mechanisms by which PAs deliver benefits. Some national or local governments have failed to undertake compensating measures to avoid the potential negative effects of establishing PAs (e.g., training, subsidies, etc.). These are essentially political questions — who shall bear the costs — hidden under BAU, which need to be worked out transparently and accountably under SEM? In general, PA stakeholder involvement, empowerment of local actors, and transparency are keys to success in SEM, especially in transitioning toward this pro-ecosystem approach.

PAS UNDER SEM CAN CONTRIBUTE TO EQUITY AND POVERTY ALLEVIATION.

Local people, typically, access training and employment in the PA (e.g., guarding, mapping, boundary marking, upgrading infrastructure, outreach). They may also become involved in income-generating opportunities with regard to the PA and its visitors (as guides, ecotourism service providers, and as purveyors of food, crafts, souvenirs, and other items). They may also work exploiting concessions for timber, NTFP, visitor services, and other opportunities. Still, more people may be involved via tourism enterprises.

There are many examples of PAs contributing to the well being and improved equity of rural peoples by providing job opportunities and increasing seasonal income, particularly in NBT and through NTFP (like rubber and brazil nut in the Amazon). In addition, there are innovative PES mechanisms like Brazil’s Bolsa Floresta program that pays indigenous households and hamlets to conserve the Amazon forest. This program began in 2008 with 2.702 families eligible to

Figure 6 SEM: Deforestation decrease as a result of compensation payments



receive “Bolsa Floresta Familiar” subsidies of \$22 per month to female-headed households who reside in conservation units and commit to stop deforesting. Villages receive support for forest guards and other aspects. It is expected that in time, these PES will reduce or eliminate both deforestation and endemic poverty. The contrasting BAU and SEM scenarios are illustrated in Figures 10.5 and 10.6.

Establishing PAs can generate short-term negative impacts when potential social, economic, and environmental effects have not been fully assessed. This was the case of St Lucia’s Sufriere MPA (ICRAN et al. 2005), where introduction of no-catch zones required that 35% of the fishing grounds be placed off limits, thereby allowing fisheries to rebound and attain higher sustainable yield levels. This action imposed a transitory cost on local fishers in the form of reduced catch and additional fuel cost to reach new catching areas. Transitional support policies to mitigate the losses incurred by the most vulnerable participants during the switch from BAU to SEM need to be part of any transition plan.

The creation of PAs, depending on the category, may result in losses to local communities who find their historical access to resources becomes limited. This is one of the externalized costs that characterize BAU. Conflict with such mistreated communities can be costly down the line, or even lead to the failure of the PA.

ECONOMIC BENEFITS FROM PAS AND COST REDUCTIONS FROM SEM JUSTIFY INCLUDING EXTERNALITIES.

Negative externalities may result from many activities in PAs under BAU; in other cases, PAs may be favored by externalities, which may become the basis for PES. In the context of the transition to SEM, the assumption of externalities and their valuation is a critical step. For example, for hydropower generation in river basins from PAs, the externality factor might be downstream siltation from visitor use or overuse of the PA. The cost of correcting this at the power plant could be specified in units of a 1000th of a dollar per kWh. If such a small unit is applied to large hydropower market and the revenues partly allocated to watershed protection in the PAs, this policy would generate a substantial flow of PES funding. Under SEM, with better control of soil disturbance in the PA, the amounts required would decline.

SEM SECURES HIGH QUALITY AND QUANTITY OF WATER RESOURCES FROM PAS, INDISPENSABLE TO MAINTAINING PRODUCTION LEVELS AND SAVINGS IN IRRIGATED AGRICULTURE, HYDROPOWER, AND POTABLE WATER.

Perhaps the most quantifiable contribution from ecosystems in PAs is high-quality fresh water supplies, low in sediments that clog infrastructure. SEM management of PAs is essential to sustain produc-

tivity and generate millions of dollars in savings by avoiding sediment removal costs.

Irrigation: The cases of Colombia, Peru, and Venezuela show that PA ecosystems are important to irrigated agriculture. For example, the Colombian National Park System feeds four of the six most important water systems in the country; 12 major agricultural districts use water from the parks to irrigate some 200,000 ha. Water supply in the Córdoba and Tolima districts depend on sources from Paramillo and Las Hermosas natural parks. These districts account for 37% of Colombia’s rice production (FAO 2010), valued at \$193 million in 2000. In Peru, the annual value of agricultural production in irrigation districts linked to PAs has been estimated at \$514 million. In Venezuela, around 20% of the area under irrigation (450,000 ha) depends on national parks.

HYDROPOWER: SEM CAN SECURE SUFFICIENT WATER FLOW AND SAVINGS (AVOIDED REPLACEMENT COSTS) IN HYDROPOWER DAM OPERATIONS.

There is solid evidence from Venezuela, among other countries, where about 73% of electricity generated in 2007 came from hydropower plants with catchments in several national parks. The impact of maintaining PAs under BAU practices may be significant: the government may lose the current savings (compared to thermal generation), estimated at \$15.2 billion annually, equivalent to 23% of the country’s 2007 budget — and that excludes the cost of environmental impact prevention measures.

The Guri Dam at the Caroní River basin, the largest hydropower system in Venezuela, is a case in point. In the 1990s, the benefit derived from watershed protection for the Caroní River basin’s hydroelectric production was assessed in a detailed cost-benefit analysis (Gutman 2002). Studies showed that power generation by this hydroelectric system would be reduced by about 10%-15% by silting, if moderate deforestation occurred. The hydroelectric system has an expected life of 60 years, and the loss of power generation would occur by the dam’s midlife. The cost of recovering the capacity lost in this (BAU) scenario is illustrated in Figure 10.7. The replacement investment would need to be built between year 25 and 29 to be ready in year 30, at an estimated cost of \$90 million to \$134 million.

Water consumption: Water supply to millions of people in large cities in the region comes from PAs, for example, the capitals of Colombia, Brazil, the Dominican Republic, Ecuador, Venezuela, and Costa Rica. Under SEM, users could secure their supply at near-negligible individual cost, while simultaneously protecting the watershed — if political will is available to move to sustainable water fees. However, this ecosystem-based water benefit is at risk. In Venezuela, for instance, national parks sustain production of 530 m³/sec, covering the water needs of over 19 million people in urban centers and small

towns. However, under current BAU practices, water from the parks may decrease by 10% to 30% over the next 20 years (Figure 10.8).

Caracas water sources, for example, lose capacity at an estimated 0.5% annually, a reduction of 0.135 m³/sec. At current marginal costs, Caracas will need to invest, on average, \$13.5 million yearly in new water sources just to keep up with the loss in supply under BAU. Shifting to SEM would be cheaper.

Further evidence is provided by the case of water supply from the Chingaza National Park in Colombia, where the Bogota Water and Aqueduct Company (EAAB) will soon reap the benefits of investing in watershed protection (SEM). A four-year conservation effort by EAAB will pay off by saving part of the \$4.5 million annual sediment removal cost incurred under previous BAU practices (GEF 2010). Without SEM, costs of sediment removal would continue to escalate. Figure 10.9 illustrates the BAU and SEM scenarios.

A great deal of work has been done on the value of water resources in terms of human consumption. Data from Chile, for instance, indicate that the fresh water service provided by the 24,000 km² Valdivia forest (a designated Biodiversity Hotspot) is worth \$16.4 million yearly. This PA has potential to benefit 7 million people. In Brazil, the Guapi-Macacu Watershed, partly within the Três Picos State Park, supplies half of the region's 1.7 million residents, with an average annual cost of \$0.35/person for headwaters protection.

MARINE AND FRESHWATER PROTECTED AREAS CONTRIBUTE TO GROWTH THROUGH BIODIVERSITY CONSERVATION.

Marine reserves contribute to increases in biodiversity and renovation of depleted fisheries that are associated with large increases in fisheries productivity. This SEM approach has increased income and jobs to local populations, as well as to industrial fishing fleets. In Brazil, an important fresh water fishery for the currently endangered pirarucu has led to establishing extractive reserves to implement community-based fishery management.

Recommendations

RESEARCH AND INFORMATION MANAGEMENT

- Assess (1) investments required to achieve SEM, including definition of SEM targets for PA systems, (2) priority areas for investment in PAs that could lead to cost-savings in other sectors, (3) existing subsidies to BAU practices that are perverse and develop strategies to progressively phase them out, and (4) the feasibility of developing new PAs to improve ecological representation on a national or regional scale. Stakeholders should be engaged at all levels.

Figure 10.7. Cost of maintaining hydroelectric power capacity (BAU)

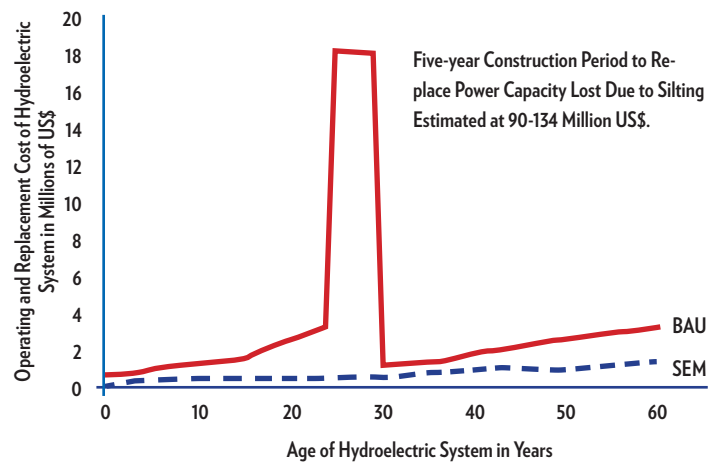


Figure 10.8. Potential decline in water supply from PAs under BAU in Venezuela.

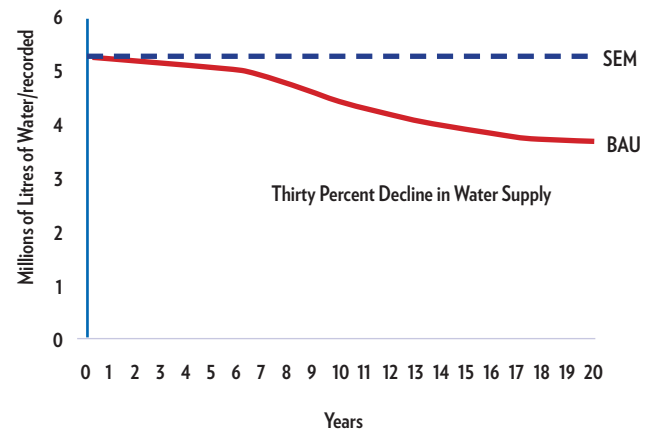
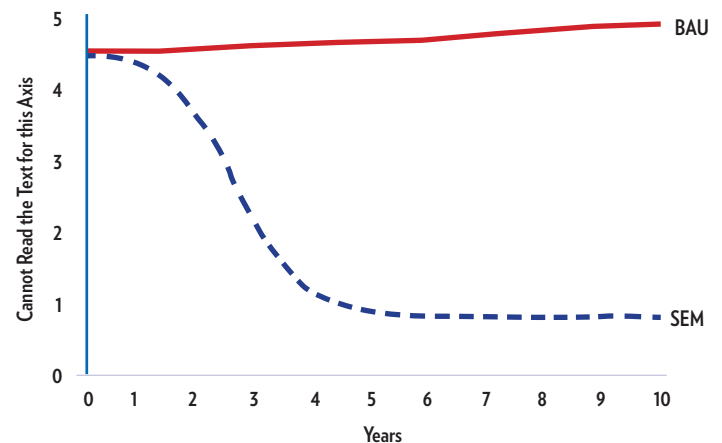


Figure 10.9. Potential decline in water supply from PAs under BAU in Venezuela.



- Determine the options for environmental fiscal reform and innovative PES financing to close the financial gaps of PA systems.
- Introduce more systematic and socio-economically rigorous valuation of PA benefits and costs, including stakeholder participation; introduce a focus on the marginal benefit of moving from BAU to SEM, and consider opportunity cost and distribution issues.
- Establish a SEM Information Management System for PA systems to provide a timely flow of sector-level information to decision makers (public and private) on matters such as ecosystem health, progress toward SEM targets, and the economic impact of PAs under SEM. Link these findings to a regional economic and sustainable development platform, such as the UN Economic Commission for Latin America and the Caribbean (ECLAC) to facilitate information sharing, regional coordination, and decision making.

PA POLICY AND FINANCE

Based on the assessments described here,

- Identify needs for consolidation of existing PAs and creation of new ones; this effort should result in a proposal that considers ecological representativity, opportunity costs (including positive externalities such as carbon, water, genetic resources, and visitation), distribution of benefits, and PA management costs and finance mechanisms.
- Provide for stakeholder participation in PA planning, implementation, and monitoring. Above all, PA systems should include those PAs that provide critical ES to support both national economic growth and local development.
- Adopt policies, consultation procedures, and investment programs to minimize the potential negative impact of new and existing PAs. Such policies will provide, for example, involvement of national and local stakeholder groups, temporary income compensation when establishing seasonal bans and no-take areas, resettlement compensation where required, and transparent mechanisms to access PA benefits. Addressing such distribution issues will, in turn, directly affect local and national support for conservation, with implications for those ES that provide national benefits.
- Introduce systems to include the benefits and costs associated with natural capital in the national accounts system.
- At the national level, introduce a results-oriented financial management policy for PAs, addressing three areas: (1) making clear the links between PAs and economic growth, (2) ensuring and increasing diversified funding streams, and (3) building capacity

to adequately manage funds. It is essential that PAs work to define realistic financial needs, based on results-oriented programs that link costs with both biodiversity conservation and economic growth goals.

- Implement a phased, multi-sector national strategy on environmental fiscal reform (EFR), including opportunities to end externalities, based on the findings of the assessments outlined earlier. EFR will require strong commitment from public and private sectors, and will address, in a balanced manner, the financial needs of local governments, communities in and around PAs, and PA funding. The multi-sector strategy would target various sectors simultaneously (e.g., water supply, energy, and mining) and will be introduced in an incremental manner, to avoid shocks and to distribute responsibility and financial contributions widely. Examples of such policies include improved water and energy pricing, ecological taxes, pollution fees, carbon caps, and forestry royalties.

INSTITUTIONAL (PUBLIC AND PRIVATE)

- Establish a ministerial-level coordination mechanism to advance the introduction of a new ecosystem-based PA management policy with strong involvement of the private sector and other stakeholders. This mechanism will link with the creation of an Intergovernmental Platform on Biodiversity and Ecosystem Services, called for in the Joint Statement of the G8/G20 Summit in Canada in June 2010.
- Assess needs for national institutional and administrative reform. To be sustainable, SEM will require a strengthened institutional environment. The durability of SEM depends on shared public and private sector commitment, and on shared accountability for maintaining healthy ecosystems and biodiversity. PA agencies could benefit from multi-sector shared responsibility for PA management costs. Co-managed and co-funded operations would involve key areas, among them environment, tourism, industry, fisheries, agriculture, energy, water and sanitation, and employment. Under BAU, sectors that use ES, such as tourism, agriculture, energy, water, fisheries, and industry, are sharing neither responsibilities nor costs.
- Continue to formulate PA system financial strategies and business plans with private sector support, to facilitate implementation of EFR, and the use of portfolios of diversified revenue mechanisms; and, also, to introduce business development units in PA agencies to be responsible for assessing and communicating the value of the contribution of PAs to these financial strategies and business plans. Peru's MINAM has taken initial steps in this direction by establishing the Directorate for PA Economic Valuation in 2009.

ANNEX 10.1. THREATS TO FRESHWATER ECOSYSTEMS AND THE POSSIBILITY OF PREVENTION BY PROTECTED AREAS

THREAT TO FRESH-WATER ECOSYSTEM	DESCRIPTION/CAUSE	ORIGIN: LOCAL	ORIGIN: CATCHMENT	ORIGIN: EXTRA-CATCHMENT	PLACE-BASED SOLUTION FOR PRO-ACTIVE PROTECTION?
DIRECT HABITAT ALTERATION	Degradation and loss	X	X		Local-to-catchment management
	Fragmentation by dams and inhospitable habitat segments	X			Protected rivers or river reaches
FLOW ALTERATION	Alteration by dams	X	X		Protected rivers or river reaches
	Alteration by land-use change		X		Catchment management
	Alteration by water abstraction	X	X		Abstraction prohibited or managed for priority systems
OVERHARVEST	Commercial, subsistence, recreational, and poaching	X	X		Fishery reserves
CONTAMINANTS	Agricultural runoff (nutrients, sediments, and pesticides)		X		Catchment management
	Toxic chemicals including metals, organic compounds, and endocrine disruptors	X	X		Catchment management; local prohibitions against point-source discharges
	Acidification due to atmospheric deposition and mining			X	None
INVASIVE SPECIES	Altered species interactions and habitat conditions resulting from accidental and purposeful introductions	X	X		Preventing introductions to systems with natural or constructed barriers to invasion
CLIMATE CHANGE	Results in changes to hydrologic cycle and adjacent vegetation; affects species ranges and system productivity			X	None (except maintaining dispersal opportunities and thermal refugia)

In nearly all cases where both local and catchments origins are listed, local stresses are transferred downstream to become catchment impacts elsewhere.
Sources: Information drawn from Brinson and Malvarez 2002; Bronmark and Hansson 2002; Malmqvist and Rundle 2002; and Tockner and Stanford 2002

ANNEX 10.2. PAs AND CROP GENETIC DIVERSITY IN SELECTED LAC COUNTRIES

COUNTRY	PROTECTED AREA	LINK TO CROP WILD RELATIVE (CWR) AND LANDSCAPES
Argentina	Nahuel Huapi National Park, IUCN Category II, 475,650 ha	The oldest (established in 1934) national park in Patagonia, the reserve contains potato CWR (<i>Solanum brevifolium</i> and <i>S. tuberosum</i>)
BOLIVIA	Madidi National Park, IUCN Category II, 1,895,750 ha	The Pampas del Heath in northern Bolivia and south-eastern Peru is the largest remaining undisturbed Amazonian grassland plain. Approximately two-thirds of the Bolivian pampas is located within this park. A wild pineapple (<i>Ananas sp.</i>), which may be the ancestor of the cultivated pineapple, is common in the Pampas. Bolivian National Parks have also been surveyed for in situ conservation of CWR, including potato and peanut (<i>Arachis spp.</i>) species
COSTA RICA	Corcovado National Park, IUCN Category II, 47,563 ha	This park in the south of the country is a genetic reserve for avocado (<i>Persea americana</i>), “nance” (<i>Byrsonima crassifolia</i>) and “sonzapote” (<i>Licania platyphus</i>)
	Volcán Irazú National Park, IUCN Category II, 2,309 ha	Located in the central highlands of Cartago province, plant species include populations of wild avocados and avocado near relatives <i>P.schiedeana</i>
ECUADOR	Galápagos Islands World Heritage Site, 766,514 ha (terrestrial area)	The Galápagos Islands are likely to contain important genetic resources, but, in general, these species have yet to be investigated. One notable exception is the endemic tomato (<i>Lycopersicon cheesmanii</i>) which has contributed significantly to commercial tomato cultivation by improving survival during long-distance transport. In a survey of tomato populations in the Galápagos Islands, several populations of <i>L. cheesmanii</i> reported 30–50 years earlier had disappeared, mostly as a consequence of human activity, highlighting the need for active conservation of CWR at this site
	Sangay National Park, IUCN Category II, 517,725 ha	This park in central Ecuador is considered “an enormous genetic reserve, and surely a source for wild relatives of crops and potentially valuable medicines”
GUATEMALA	Mario Dary Rivera Protected Biotope, IUCN Category III, 1,022 ha	After more than 50 years, the rare pepper, <i>Capsicum lanceolatum</i> , was rediscovered in a virgin remnant of the Guatemala cloud forest, preserved as habitat for the resplendent quetzal (<i>Pharomachrus mocinno</i>).
	Sierra de las Minas Biosphere Reserve, IUCN Category VI, 94,796 ha	This mountain range in eastern Guatemala contains several species of Solanaceae that “represent potential germplasm resources of food plants, including local varieties of tomatoes”
MEXICO	Sierra de Manantlan Biosphere Reserve, not categorised on WDPA, 139,577 ha	The existence of <i>Z. diploperennis</i> and other CWR is likely to be due to the traditional agricultural practices of slash-and-burn cultivation (coamil) and cattle-ranching
	Sierra Norte de Oaxaca Community Protected Natural Areas, not on WDPA	WWF has helped create community PAs in Mesoamerican pine-oak forest in Sierra Norte of Oaxaca, a known centre of potato diversity. Ixtlán de Juárez protects 9,000 ha of pine-oak, cloud, and tropical forests; Santa Catarina Ixtepeji protects 4,225 ha of pine-oak forest; Santa María Yavesia protects 7,000 ha of pine-oak forest; and four communities of the Union of Zapotec and Chinantec Indigenous Communities (UZACHI) protect 12,819 ha of pine-oak, cloud, and tropical forests. The area protected is expanding rapidly. During the past two years, an additional 18,970 ha of community PAs have been established in San Francisco La Reforma I (670 ha), Santa Sociedad Río Grande Teponaxtla (3200), San Francisco la Reforma II (2500) Cruz Tepetotutla (4600), San Antonio del Barrio (2200), San Pedro Tlatepusco (2300), and Nopalera del Rosario (3500)
	Montes Azules Biosphere Reserve, IUCN Category VI, 331,200 ha	Montes Azules is located in the state of Chiapas in southeast Mexico. It is one of the largest areas of humid tropical forest in Mexico and Central America, containing some 500 species of trees, including wild avocados
	Pico de Orizaba National Park, IUCN Category II, 19,750 ha	Pico de Orizaba includes populations of the wild avocado (<i>P.americana</i>)
PARAGUAY	Mbaracayú Reserve, IUCN Category IV, 1,356 ha	A USDA/Paraguay project is researching herbarium and museum records and other species inventories to determine geographical locations of CWR in Paraguay and especially in its PAs. The objective is to use the data to create or revise management plans within existing PAs and recommend sites for new PAs in CWR “hotspots”
PERU	Bahuaja Sonene National Park, IUCN Category II, 1,091,416 ha	Bahuaja Sonene protects the Peruvian area of Pampas del Heath. The park home to Peru’s largest population of Brazil nut (<i>Bertholletia excelsa</i>) trees, over 30,000 ha, and protects a number of native fruits, including wild pineapple and guava (<i>Psidium sp.</i>)
	Manú National Park, IUCN Category II, 1,716,295 ha	The lowland floodplain forests of the Manú River harbor a number of commercially important or potentially important fruit trees like cacao (<i>Theobroma cacao</i>) and “sapote” (<i>Quararibea cordata</i>); It has been suggested that the forests of Manú “probably include a disproportionate number of the general region’s economically important plants, and they are exceptionally important to maintain germplasm for future programs of genetic improvement”

SOURCE: STOLTON ET AL. 2006

Annex 10.3. IUCN Protected Area Management Categories

CATEGORY Ia. Strict Nature Reserve: protected area managed mainly for science. Definition: Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.

CATEGORY Ib. Wilderness Area: protected area managed mainly for wilderness protection. Definition: Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.

CATEGORY II. National Park: protected area managed mainly for ecosystem protection and recreation. Definition: Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

CATEGORY III. Natural Monument: protected area managed mainly for conservation of specific natural features. Definition: Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.

CATEGORY IV. Habitat/Species Management Area: protected area managed mainly for conservation through management intervention. Definition: Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.

CATEGORY V. Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation. Definition: Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

CATEGORY VI. Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems. Definition: Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

ANNEX 10.4. EXAMPLES OF ECONOMIC CONTRIBUTIONS OF PROTECTED AREAS TO POVERTY REDUCTION IN THE LAC REGION

COUNTRY, HDI RANKING & GDP/CAPITA*	NAME OF PROTECTED AREA AND DETAILS**	CONTRIBUTION TO ECONOMIC DIMENSION OF POVERTY REDUCTION
GUATEMALA HDI RANK: 118 GDP/CAP: \$4,313	Maya Biosphere Reserve (2,112,940 ha, MAB, 1990), including the Tikal National Park and World Heritage Area, Laguna del Tigre National Park and Cerro Cahuí Protected Biotope.	The Maya Biosphere Reserve provides employment for over 7,000 people in the Petén region of Guatemala and generates an annual income of approximately \$47 million. The reserve is credited with close to doubling local family incomes. 5% of net earnings from ecotourism goes to local people and is invested in community projects such as handicraft production and local schools. Women are an important target group for these projects.
BOLIVIA HDI RANK: 115 GDP/CAP: \$2,720	Kaa Iya del Gran Chaco National Park and Integrated Management Natural Area (3,441,115 ha Category IV, established 1995).	A \$3.7 million program that included a \$1 million trust fund, has been created to support the national park. \$300,000 is earmarked for strengthening indigenous organizations, about \$700,000 for pilot sustainable production activities and \$1.5 million to support land titling for indigenous territorial claims by the Guaraní-Izoceños, the Chiquitanos and the Ayoreodes.
	Eduardo Avaroa Reserve (714,845 ha, Category IV, established 1973).	About 25% of the park revenue should go to the local Quetena communities, although in reality it would seem that less than that amount is actually transferred.
ECUADOR HDI RANK: 83 GDP/CAP: \$3,963	Awa Indigenous Protected Area (101,000 ha, Category VI, established 1988).	There are 4,500 Awa living in 21 communities. They manage their protected area for sustainable timber. While timber intermediaries paid \$60/m ³ for sawn "chanul," the Awa Forestry Programme sells its product for \$240/m ³ (anticipating production of 200 m ³ /year, therefore a total of \$48,000/year). Of the \$240, \$60 goes to external costs, \$60 goes to community members who worked on the extraction and the remaining \$120 is a stumpage fee to the community (or family).
	Cuyabeno Reserve (603,380 ha, Category VI, established 1979).	For five communities in the reserve, per capita annual income from ecotourism has been estimated at between \$80 and \$175. In Playas (which is situated inside the reserve) the wage for permanent employment at the Flotel Hotel is about double the average for local daily wage.
	Galápagos Marine Reserve (13.3 M ha, Category VI, established 1996), includes the Galápagos National Park (799,540 ha, Category II, est. 1959).	The area was also designated as a World Heritage Site in 1978; some 16,000 people inhabit five of the Galápagos islands, and because of better economic opportunities population growth continues by immigration from the mainland. Annual revenues from tourism which supports 80% of the islands' residents amount to \$60 million.
PERU HDI RANK: 82 GDP/CAP: \$5,678	Manu National Park (1.5 million ha, Category II, established 1973).	Accommodation for ecotourists provides an estimated \$500,000 per annum to the local indigenous communities living in and around the park.
BRAZIL HDI RANK: 69 GDP/CAP: \$8,195	Mamirauá State Ecological Station, 1,124,000 ha, Category Ia, established 1990).	An Economic Alternatives Programme started in 1998 targeted 10,000 people living in five villages in the area. Subsequently incomes have increased by 50% and in some areas by 99%. Infant mortality has declined by 53% with better health education and water quality.
TRINIDAD & TOBAGO HDI RANK: 57 GDP/CAP: \$12,182	Matura (8,200 ha, Category II, established 1990. Designation unclear).	It is estimated that income generated from turtle-viewing in Matura averages \$28,572 per season, between March and August. This income is managed by the community.
MEXICO HDI RANK: 53 GDP/CAP: \$9,803	El Triunfo Biosphere Reserve (119,177 ha, Category VI, declared a Man and Biosphere Reserve in 1990)	Household income has increased by between 50-125% thanks largely to agroforestry activities.
COSTA RICA HDI RANK: 48 GDP/CAP: \$9,481	Tortuguero National Park (18,946 ha, Category II, established 1975)	In 2003, direct income to the Gandoca community (situated 125km from the Park) was about \$92,300; 6.8 times more than the potential income from selling turtle eggs on the black market. Each local tour guide in Tortuguero earned on average \$1,755-\$3,510 in a five month period; this is two to four times the minimum wage. Overall, about 359 jobs have been generated by ecotourism. In addition, a local high school, clinic, and improved water and waste treatment were set up due to revenue from the park.

* All GDP figures are taken from UNDP 2006

** All protected area data are taken from UNEP WCMC World Database on Protected Areas unless stated otherwise.

CHAPTER 11.

SUSTAINABLE ECOSYSTEM MANAGEMENT AND WATER: THE BENEFITS OF HYDROLOGICAL SERVICES

Bruce Aylward¹ and Ray Hartwell²

11.1 INTRODUCTION

This chapter synthesizes available information —conceptual and empirical— on the relations between land management, hydrological services, and human welfare, with emphasis in Latin America and the Caribbean (LAC) countries. The analysis addresses an opportune question: can sustainable ecosystem management improve water supply and quality, compared to conventional approaches to land and water stewardship?

Water resource managers face burgeoning demand for water in agriculture, hydropower, cities, and industry. Waste from growing economies increases pressure on the capacity of both land and waters to assimilate this waste. The mounting need for hydrological services parallels growing concern for the negative impacts that dams, water withdrawals, discharge, and erosion have on the ecology of freshwater systems and on the sustainability of essential ecosystem goods and services.

Addressing this dilemma will require good land and water management, linked to regulation and market incentives. Effective interventions require knowledge of upstream-downstream relationships among land and water use, hydrologic services, economic activity, human-made infrastructure, and ecosystem function.

Conventional wisdom holds that deforestation leads to losses

in water production and the costly problem of sedimentation in downstream hydropower, water supply, and irrigation facilities. Many observers also accept that forests attract rainfall and act as a sponge, soaking up and storing excess water for use at later times, thus, offering increased water supply, flood reduction, and greater dry season flow to agriculture and other productive activities. While these views are widely shared and can drive policy and action, they are not supported by the evidence. The divergence between popular belief and scientific understanding is a source of concern.

The idea of sustainable ecosystem management (SEM) has long existed as a dialogue among conservationists, held apart from the rhetoric and reality of traditional water resource developers. This chapter attempts to bring those dialogues together, with a critical look at what is known about SEM and the gains in efficiency and equity to which these practices may contribute. The potential of hydrologic opportunities under SEM is assessed in two steps: (1) how a shift to SEM may affect hydrological services across a watershed; and (2) how those changes in function link to economic utility and the distribution of costs and benefits.

As the net benefit of investing in SEM emerges, trade-offs or synergies with water resource infrastructure and other investment alternatives must also be considered. Unsurprisingly, this is a complex task without straightforward or generic solutions. However, the guidance provided in this chapter will help decision makers sort through options in specific cases.

The underlying observation of this chapter is that downstream economic activity is affected by upstream water management and land

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It is not intended that the main Report be read straight through; most readers will have specific interest in one or a few sectors. Chapters have been made free-standing, not dependent on reading in sequence. But it is advised to read the introduction and methodology prior to reading a sector chapter as the key concepts are described there.

- **Business as usual (BAU)** is the practice of developing water services without taking into account offsite effects, typically leading to downstream impacts from forest conversion and erosion; and
- **Sustainable ecosystem management (SEM)**, which is a set of practices that aims to optimize use of the entire watershed, taking downstream effects and stakeholders under consideration in decision making at each level, typically promoting maintenance of intact headwaters ecosystems and the practice of low-impact agriculture.

Trade-offs between hydrological services produced under these BAU and SEM paradigms are estimated. Benefits and costs are then compared across a series of economic activities, based on review of field experience to date. Finally, policy response and decision making options are explored in the light of case studies from the LAC region.

KEY FINDINGS

The main messages on the potential of SEM for hydrological services in LAC are as follows.

1. **Water quality is the main aspect improved by SEM.** The effects of land management on downstream water quality shape economic production. Sediment load, agricultural run-off, and human or animal sewage are the factors most commonly affecting water quality.
2. **Forests do not enhance water yields.** The widely held idea that forests raise water production is not borne out by studies, which have shown that deforestation often improves water yields. In some cases, forests may increase dry season flow. Such effects depend on site-specific factors.
3. **No generic answers.** The type, volume, and value of hydrological services produced in a given watershed depend on specifics of two sorts: the natural elements that condition hydrological functions — like climates, soils, and basin shapes —

and investment in water resources infrastructure and existing management regimes. While a few general rules apply, their combined effects in particular situations are complex, making necessary case-specific analysis.

4. **Payment for Environmental Services (PES).** Off-site impacts of hydrological services should influence economic decision making by upstream land managers, but only do so when links like PES are in place. In recent decades, the LAC region has helped develop the environmental policy field by innovative experimentation with PES in many countries. Such schemes now come in many forms and sizes, spanning the continuum from private to public initiatives.
5. **Risk aversion is a primary concern.** In intact headwater catchments, the default option is to maintain forest cover to protect downstream economic uses of water and physical infrastructure.
6. **Infrastructure is a key factor.** In degraded headwater catchments, maintaining the productivity of existing infrastructure is a primary concern; caution should be exercised before investing in major land-use change.
7. **SEM can support pro-growth policies.** Considering overall net benefits under SEM can lead to continuing lucrative economic activities begun under BAU, such as sediment-causing activities in which the benefits of sedimentation outweigh the costs.
8. **SEM is likely to benefit the poor, remote, and marginal segments of society** disproportionately, since the benefits of BAU and of water development infrastructure accrue more often to urban populations and wealthy sectors. The benefits of SEM are often realized by those without access to infrastructure or to a social safety net, while the costs of BAU are often visited on the poor, rural, and marginal groups, in the form of degradation of water quality and other externalized costs.

11.1 HYDROLOGICAL SERVICES AND SUSTAINABLE ECOSYSTEM MANAGEMENT

Hydrologic function is seen as a series of cascading relationships — from the headwaters to the sea — in which ecosystems in conditions that vary from pristine to heavily-modified interact with built infrastructure and human activity across the landscape. Considerable scientific and economic work has been done on watershed mana-

gement, the role of forests, and downstream hydrological services, though much still remains to be learned.

This section explores the nature of hydrological services and their economic contributions. Then, the section examines how hydrological services fare under two generalized scenarios for ecosystem management: business as usual (BAU) and sustainable ecosystem management (SEM).

Hydrological Services

Watershed management encompasses a wide range of ecosystem and natural resource functions that are jointly provided by land and water. To focus effectively, this chapter develops a narrower emphasis on hydrological services, referring to the benefits derived from the use of water in its many forms.

Economic uses of water can be divided into classes of hydrological services (Table 11.1). Many uses involve fairly direct collection, harvesting, or enjoyment of water. These hydrological services can be grouped together as uses of “ecosystem water.” A second category refers to water uses provided through water resource infrastructure, “value-added water.” Finally, there is a set of “water related services,” also provided through infrastructure, including hydroelectric power and flood control.

It is clear that hydrological services originate naturally in ecosystems, but are then improved by application of human labor, technology, and physical capital. Here, the focus will be not so much on direct human interaction with water resource but more on the indirect impact that the upstream use of land and water have on the downstream production of hydrological services. The roles that ecosystems and infrastructure play in providing hydrological services will be examined, to assess the potential efficiency and equity gains of moving toward SEM practices and away from BAU practices.

Relation Between Land Use and Hydrological Services

Hydrological services refers to benefits derived from use of water. On the ecosystem side, a series of processes produce water and its related services. These processes involve interaction between geologic, hydraulic, chemical, biological, and ecological functions, which determine how, when, and in what quantity and quality precipitation percolates through or runs off to become available as soil, ground, or surface water.

Land management affects these natural processes and changes the water cycle principally by altering vegetation cover and soil properties, influencing a series of hydrological functions including those

related to

- o **Water quantity:** amount precipitated; annual water yield; seasonal flows, particularly base flow; groundwater recharge; storm flow response or flood flows; and
- o **Water quality:** erosion and sediment loading; run-off and leaching of pollutants that affect the physical, chemical, biological, and ecological quality of water; and sedimentation, aeration, filtration, microbial action, and other natural purification processes.

Land management upstream in a watershed is linked to ecosystem function and human welfare downstream through its effect on hydrological services. The use of water resource infrastructure also has downstream consequences. Diversion of water for domestic supply or irrigation, for example, reduces downstream flow and may impair water quality by reducing capacity to assimilate pollutants. However, the focus of this chapter is on ecosystem management (not infrastructure) and how intervention in upstream ecosystems affects downstream welfare. In that regard, hydrological services—particularly in LAC—are often considered in the context of forested upper watersheds that provide water-related services, often involving downstream infrastructure. Science and conventional wisdom are not in agreement on the cause and effect relationships that underlie those services, as discussed below.

The relationship between land management and hydrological function affects delivery of hydrological services, as reflected in water *quality* and *quantity*. These are influenced by management practices that alter the (a) quantity of precipitation that is intercepted, (b) the amount evaporated from surfaces—, particularly vegetation, but also soil, (c) the quantity of water that is transpired and evaporated by plants, (d) the rate at which water infiltrates the soil and, hence, the level of surface runoff, (e) washing or leaching of materials, nutrients, and pathogens into ground and surface waters, and (f) natural cleansing processes in soil and waterways. Land-water interactions can be complex; rarely does a process occur in isolation. Actual changes in flow, quality, and timing will be difficult to predict or ascertain with any degree of certainty (Bruijnzeel 2004).

Removal of natural vegetation and disturbance of soil generally worsen water quality (Bruijnzeel 2004). For water quantity, in contrast, it is impossible to make such a simple statement. The effect of land use and vegetation on water quantity is obscured by confusion and disagreement. Generally, studies suggest that vegetative cover with high rates of interception and transpiration—such as many types of forests and certain crops—will evapotranspire (“consume”) more water annually than other types of land cover. Thus, preserving forests may result in lower total annual flows, because the thick vegetation heated by the sun pumps out more water than would,

TABLE 11.1. HYDROLOGICAL SERVICES

USES/BENEFITS OF WATER: HYDROLOGICAL SERVICES	NOTES ON KINDS OF WATER USE (GW=GROUNDWATER, SW=SURFACE WATER)	LEVEL OF ECONOMIC ACTIVITY	EXTENT OF CONSUMPTIVE USE
A. ECOSYSTEM WATER			
1. Precipitation			
Agriculture	Rainfed agriculture	Household & Production	Major
Domestic	Rainwater harvesting	Consumption & Household	Minor
Ecosystem	N/A	All	Varies
Support			
2. Groundwater			
Domestic	Collection from springs	Consumption & Household	Varies
Agriculture	GW pumping	Production	Major
Ecosystem	N/A	All	Varies
Support			
3. Surface Water			
Domestic	Collection	Consumption	Minor
Agriculture	Flood recession and riverbank farming	Household	Minor
Boating	N/A	Consumption	None
Transport	N/A	Household & Production	None
Ecosystem Support	N/A	All	Varies
Cultural & Recreation	N/A	Consumption	None
Fishing	Subsistence and commercial harvest	Household & Production	None
B. VALUE-ADDED WATER			
Bottled water	GW collection, GW pumping	Consumption	Minor
Irrigation Water	SW diversion, SW storage, GW pumping	Household & Production	Major
Municipal & Industrial Water Supply	SW diversion, SW storage, GW pumping	All	Varies
Transport	SW: storage, channelization, locks	Production	None
Fishing & Recreation	SW: storage, storage release	All	None
C. WATER-RELATED SERVICES			
Hydroelectric Power	SW: storage, diversion, impoundment	Household & Production	Minor
Flood Control	SW: storage, channelization, levees	Household & Production	None

say, an empty field. However, the degree to which water is temporarily retained by forests and metered out — moderating the low flows in dry periods and lessening peak flooding in wet seasons — may be of more consequence than total annual downstream water yield. Timing, as much as amount, can be critical with respect to water provision.

Forest conversion often brings a land management regime that increases soil compaction and decreases rainwater infiltration rates, slowing recharge of underground aquifers and increasing surface runoff. The evidence suggests that as long as these effects of land-use change are not so large as to outweigh the reduction in evapotranspiration, then even conversion of forest to pasture may lead to higher dry season flow (Box 11.1). Effective land management may produce both greater annual yield and higher downstream base flow after conversion of natural vegetation, while poor management practices may have the reverse effect. There is enough variation in the effects of specific land-use actions to make generalization difficult.

Clearly, the popular perception that removal of natural vegetation must lead to less water and lower dry season flows is faulty; this condition applies only under a limited set of circumstances. Care must be taken not to overstate or stereotype the hydrological benefits of specific vegetation types. Instead, the task is to identify the correct prescription in each place to enhance production of the desired ES, be they hydrologic, esthetic, biodiversity, forest products, or others.

Business as Usual (BAU)

Under BAU management, the focus is on net benefits to the enterprise, disregarding off-site or otherwise externalized effects. Land, water, and other resources are employed in conjunction with physical capital (i.e., infrastructure) to maximize financial benefits solely to landowners and firms in a particular reach of the watershed. Little or no attention is paid to the downstream effects of resource use and infrastructure development on other human and

Box 11.1. Conflicting Views and Hydrological Function: Water Yield, Groundwater Recharge, Seasonal Flows, and the Sponge Effect

In both temperate and tropical zones, when human activity reduces vegetation by removing forests, evapotranspiration is also reduced, increasing the annual total water yield from the watershed (Bosch and Hewlett 1982; Bruijnzeel 2004). This observation runs counter to the popular perception that forest areas produce more water than non-forest areas. This mis-perception is understandable. First, forests grow where there is more precipitation — i.e., precipitation causes forest and not vice versa. Since it does rain more where forests are found, those areas seem to “produce” more water than nearby places that are naturally non-forested. This does not mean that a given area will yield more water if covered with forest than if cleared. The laws of physics and countless scientific studies are clear that less water will run off or infiltrate in areas with higher evapotranspiration, such as forests (Bosch and Hewlett 1982).

Human alteration of natural vegetation has a less clear-cut impact on seasonal flows, particularly on dry season base flow, the stream flow component derived from the discharge of groundwater as opposed to overland, rain-fed inflows. Base flow is of particular importance to water quantity management during the dry season when flow is at its lowest levels. Although lower levels of evapotranspiration following vegetation removal can cause dry period base flow to rise, this response may be reduced or reversed if soils are so compacted by the subsequent land use that infiltration of precipitation is significantly curtailed (i.e., a reduction in the “sponge” effect ascribed to forests and other natural vegetation, caused perhaps by trampling during grazing). Nevertheless, much experimental work has shown that the evapotranspiration effect overwhelms the infiltration effect (Bruijnzeel 2004). If infiltration rates are normally high, then only severe compaction will reduce them significantly during rainstorms. The bulk of scientific observation to date reveals that, more often than not, the removal of forest leads to a rise in dry season base flow; the reduced evapotranspiration seems to outweigh the lessened infiltration due to land-use change (Bruijnzeel 2004).

Much of the evidence against the “sponge” effect comes from experimental catchment studies. Questions remain as to whether experimental conditions sufficiently reflect real-world situations; however, current scientific understanding argues against reliance on the “sponge” effect as a basis for management and policy decisions (Aylward 2005). Further, research has shown that the hydrological impact of land-use change depends not just on the effect of the initial intervention but also on subsequent land use and the specific management regime (Bruijnzeel 2004).

ecological uses of the hydrological system in the watershed, including irrigation, municipal and industrial water supply, hydroelectric plants, and support of both inland waters and wetland ecosystems. Thus, a decision on whether to produce more water by deforesting a watershed would consider only net gain to be obtained there by the interests promoting this strategy but not the cost of sedimentation to downstream actors nor the impact of biodiversity loss on the public interest.

Practices that typically cause off-site impacts include upstream land clearance, poor soil management, use of agrochemicals, discharge of untreated human or animal sewage, release of industrial effluent, excessive water withdrawals, and modification of the hydrological regime through in-stream barriers, channelization of waterways, and poor riparian management. Even conservation efforts can be BAU approaches if they do not take downstream effects into account, as when a wildlife restoration project increases risk to municipal water supplies from pathogens, such as *Giardia* and *Cryptosporidium*, carried by wildlife (National Research Council 2000) — or when a forest regeneration project reduces downstream water yields.

From a policy standpoint, the concern is for hydrological services that are likely to be produced in lesser or greater quantities than would be optimal for society as a whole. This applies to services where production costs are not borne by the beneficiaries, as when the cause of change in the services is not located where the effect is felt. Costs external to the production process can lead to classic market failure, where the optimal level of services is not produced by free market exchange.

Sustainable Ecosystem Management (SEM)

Under SEM management, the focus is on optimizing long-term outcomes on a wider scale. Land, water, and other resources are employed in conjunction with physical capital and ecosystem management to maximize economic benefits within the watershed. This is achieved by internalizing relevant upstream / downstream impacts in the financial calculations of planners, landowners, and firms, as well as by diligent public and non-profit management of key natural assets, including lands, streams, wetlands, lakes, rivers, and estuaries. Investments in ecosystem management, including public ownership and management, are undertaken where they are cost-competitive with physical capital alternatives or complementary to these alternatives, and where they provide ecosystem resilience that guarantees the livelihoods and basic needs of the population.

Surpassing BAU practices and moving toward SEM approaches involves finding ways to translate changes in downstream economic welfare into an effective inducement for changing upstream

behavior. In the past, this consideration might have been seen as the responsibility of government (i.e., collective action) to structure a feedback loop to change the incentives facing the land manager. However, the evolution of market systems for payment of ES has challenged this notion: the merit of finding ways to tap into the pockets of those who are directly impacted — the downstream economic agents — is now emphasized (see Section 11.5).

In a natural state, land management deals primarily with intact ecosystems with natural hydrologic function. Land management under BAU is a departure from this state of nature. Typically, this approach would be expected to have the following impacts:

- o Sediment load increases,
- o Greater nutrient and chemical levels,
- o Annual water yield increases (surface and ground waters),
- o Peak flows (flood flows) may increase locally, and
- o Dry season base flow may be affected, but the direction is specific by situation.

In a shift from BAU to SEM, altered land management leads to change in these downstream hydrological outputs, which generally improve the volume of stream flow or groundwater recharge over a given period, and the levels of sediment, nutrients, and other chemical/toxin loads carried, or both. A number of factors affect how BAU may be transitioned to SEM, internalizing a wider scope of costs and benefits —and influence the consequences of this transition for human welfare.

Within a given land use there will be a range of possible management practices (i.e., conversion of forest to agriculture, a land-use change, can result in any of several post-conversion practices — different types of pastures, cropping, agroforestry systems, etc.). These will greatly influence the extent to which the effects of land-use conversion are significant or persist. In the humid tropics, it is clear that land management practices following conversion are as important in driving hydrological outcomes as the land-use change itself (Brijnzeel 1990, 2004). Thus, it is the package of land management practices that define SEM in a given instance. The variation in management practices within a particular land-use type can offer multiple options for SEM.

Different land-use practices will alter vegetation and infiltration capacity, thereby affecting evapotranspiration, overland flow, sediment transport, and groundwater recharge, causing a variety of potentially opposing changes in hydrologic function. Yet, knowing whether hydrologic function is increased or reduced does not necessarily reveal the direction of the accompanying change in net economic benefits.

THE ROLE OF WATER RESOURCE INFRASTRUCTURE

Water management, obviously, has a role equal to that of land use, but management acts mostly via installation and operation of infrastructure and, thus, is not the driver of interest — built infrastructure is taken here as a situational variable or constraint.

Nevertheless, an understanding of water resource infrastructure and its consequences for hydrological services is imperative. Infrastructure development downstream can mitigate the severity or change the direction of the effects of upstream events like land development or ecosystem conservation. Similarly, infrastructure built upstream from ecosystems will alter their hydrologic function and hydrological services. Understanding how the presence (or absence) of infrastructure influences economic value and affects SEM is an important challenge.

For example, surface water storage facilities are intended to provide a water supply when water would not naturally be available. In consequence, once storage is in place, efforts to conserve an ecosystem to restore natural storage function may no longer be of value. Certainly, these storage facilities are likely to be less valuable than if undertaken where built storage is not available. As a result, estimates of this ecosystem service value related to regulating hydrology and protecting water quality may be overstated when the analysis omits the role of existing infrastructure. In effect, the sunk costs of infrastructure have altered the potential benefits of ecosystem conservation. An additional example relates to the installation of water treatment facilities designed to bring water up to standard for public consumption. Such facilities also protect against potential threats to water quality. Their existence means that the quality of incoming water does not matter as much as if the facilities were not in place. A decline in water quality would impose additional costs, but likely less severe ones than if the facility did not exist.

These examples underline the importance of fully recognizing the function of built infrastructure when analyzing upstream / downstream cause and effect relations. Within the landscape mosaic in a large river basin, infrastructure and “natural” ecosystems may be located in “leapfrog” fashion up and down the basin. Understanding how these two different kinds of systems interact to generate hydrological services (or disservices) is critical to broad, basin-scale SEM.

11.3 COSTS AND BENEFITS

This section provides an overview of (1) the ways in which changes in hydrological services affect economic costs and benefits, and

(2) how economic methods are applied to valuing the downstream consequences of changes in upstream land use and management.

Valuing Changes in Hydrological Services

To link land-use change to economic effects, we must see how hydrological services contribute to economic utility, and learn the direction and magnitude of the economic consequences of altering hydrologic function.

A hydrological service may relate to human well-being in three ways:

1. The service may enter directly into *individual utility*, for example, if the degree of suspended silt in surface water keeps someone from drinking from a stream or lessens the pleasure derived by a swimmer.
2. The service may be an input to the *household production* of utility-yielding goods and services, for example, if poor quality of water drawn from a stream affects the health of people in the household.
3. Finally, the service may serve as a factor input in *production of a marketed good* that, in turn, enters into the production of other goods, household production, or individual utility; for example, if stream flow is used to generate hydroelectric power that is, in turn, consumed by businesses, households, and individuals.

While the classification may change with the context, each hydrological service can be assigned to the likely economic process through which value is realized (as in Table 9.1, presented earlier). The following analysis paragraphs identify the general nature and importance of downstream effects:

Direct Consumption and Individual Utility: In both higher and lower income economies in LAC, changes in hydrological function will affect utility directly through a change in water quality or quantity that directly affects aesthetic values. For example, muddied waters may inhibit bathing or drinking, or lower the attractiveness of a recreation site, reducing the utility associated with these individual uses. Individuals may derive satisfaction directly from the knowledge that free-flowing rivers continue to exist in their natural state, regardless of their past or planned future use, and donate to river conservation organizations. In lower income economies, standards may be less demanding and consumers may be less willing to pay directly for hydrological function (Hearne 1996).

Inputs to Household Production: Household utility is a function of a mixture of services, including hydrological ones, potentially involving both marketed goods and non-marketed hydrological outputs. For example, changes in dry season base flow or water quality may

affect the quantity of bottled water or the number of water filters that are purchased by the household to provide drinking water (the utility-yielding service) to its members.

In higher income countries in LAC, this model is applicable to recreation. For instance, stream flow may be a factor, along with rafting equipment and other inputs in producing a rafting experience for local or international recreationalists. Similarly, changes in water quality may affect the species composition of systems prized for fishing or diving. Storm flow and flooding are other examples where hydrological outputs may affect developed households directly, but, by and large, household “use” of water and other hydrological outputs is more often achieved via purchase of marketed outputs produced by the public or private sectors, for example, potable water for domestic use, electric power from hydroelectricity, food produced by irrigators, and navigation from ferry services.

In lower income countries, willingness to pay for recreation is likely to be limited to that of the higher income sectors, including foreign tourists. Hydrological services more directly affect the rural household that uses water for domestic and agricultural use, waterways for navigation, and waterpower as an energy source. Thus, stream flow and water quality may serve as inputs (along with other marketed or non-marketed inputs of labor and capital) into the preparation of food and drink, subsistence farming, transport of produce to market, and many other sources of utility. If alteration in dry season base flow due to upstream land use reduces the water available for irrigation, then households may need to purchase food that they previously grew. In this manner, changes in non-marketed hydrological outputs of land use can impact household economic utility. In developing countries, most rural populations will experience the hydrological impact of land-use change through the household production function.

Inputs to Production: Hydrological services can also appear directly in the production function of firms along with other factor inputs. Production of the marketed good by the firm will then be a function of capital, labor, and non-marketed hydrological outputs of a watershed (as shaped by upstream land use).

Production is initially assumed to be an increasing function of capital and labor, so that an additional unit of each input will yield an increase in whatever is being produced. Typically, production is assumed to be an increasing function of the environmental service as well. However, in the case of hydrological outputs, this may not be strictly true. For example, an increase in stream flow may have a positive impact on production in the case of hydroelectric power generation. Meanwhile, an increase in sediment delivery by the faster flowing stream may lower production due to displacement of reservoir volume. Given that hydrological functions and their economic impacts will be site specific, it is not possible, *a priori*, to draw any generalization about which effect will predominate.

Change in hydrology (in this case, driven by a change in upstream land use) will, thus, alter both the cost curve for production as well as the demand for inputs of capital and labor. Once prices for capital and labor are considered, the producer will substitute between capital, labor, and hydrological outputs (the factors of production) to minimize overall production cost.

It is worth observing that the role of hydrological services as inputs into production is felt across both higher and lower income economies in LAC. All countries have water-related services—water supply, hydropower, irrigation, and flood control—that are linked back to the level of ecosystem management. The more developed the economy, the more likely the populace relies on commercial or public services through connection to electrical grids and water delivery systems. It is often the urban poor and rural inhabitants of developing economies who rely more directly on streams and rivers for water-related services. Thus, in LAC, the extent to which the impact of BAU or SEM is felt through market-oriented production, rather than through the household production function, will vary with socioeconomic group and geography.

The Economic Valuation Literature

Here, a quick review of the global literature is undertaken: examined first are articles on water quality, then, articles on water quantity. Given the paucity of rigorous, peer-reviewed valuation studies in the literature, this section draws on the full range of material available: studies from both temperate and tropical areas, and from both developed and developing countries. In Section 11.4, the evidence is regrouped by type of water-related service and examined in light of expectations that can be drawn for the LAC region.

WATER QUALITY IMPACTS

For site-specific analysis of economic damage caused by poor water quality, standard economic valuation methods are well described (Bockstael et al. 1987; Bouwes 1979; Duda 1985; Lant and Mullens 1991; Ribaldo and Young 1989; Ribaldo et al. 1986; Smith and Desvousges 1986; Willis and Foster 1983; Young 1996). In a developed country context, many such case studies exist. However, most of these studies focus on water quality impacts on recreation, tourism, and property values. Few studies are linked to land use. Furthermore, nor do these studies evaluate damage that is directly related to land-use change. The literature on water quality impacts related to land management looks at the effects of erosion and downstream sedimentation on built infrastructure, in both developed and developing countries. Studies of externalities associated with sedimentation are found in the literature on tropi-

cal moist forests and temperate agricultural production systems. The economic activities examined and types of values estimated by these studies are summarized below.

In a comprehensive review of the off-site costs of erosion in the U.S., Clark (1985) identifies a range of economic impacts that eroding soils may cause: impact of sediment on biological systems, lake clean-up, sediment damage in floods, and harm to productive activities and consumption by residual sediment in water supplies. Thus, even a single hydrological output, say, sediment yield, may cause diverse external effects, complicating the valuation exercise.

These studies confirm that, in general, economic utility will go down as sedimentation goes up and, thus, that utility will also be a decreasing function of BAU land uses such as logging or grazing. In other words, land-use change that modifies natural vegetation can be expected to produce negative water quality externalities. Sedimentation may also confer benefits: for example, illegal dredging of deposited sediment in the Ping River, Thailand, demonstrates positive externalities associated with sedimentation (Enters 1995). Sediment transport has also been seen to increase soil fertility on footslopes (van Noordwijk et al. 1998). Still, such benefits only reduce the net negative effect of sedimentation.

A number of studies demonstrate significant external effects. For the U.S., Clark et al. (1985) gathers research on practically every conceivable off-site impact of eroding soils to provide a nationwide estimate of the annual damage caused by soil erosion of \$5 billion (2006 dollars). Even so, Clark concludes that this figure may be severely underestimated; the figure omits the effect of erosion on biological systems and, subsequently, on economic production and consumption. Clark's figures relate to water quality more generally, not simply to the effects of soil erosion, and include the effects of pesticides and fertilizers that are used in agricultural production. Nonetheless, Clark's estimates serve the purpose of dramatizing the potential magnitude of the off-site damage caused by soil erosion and highlighting the potential value of SEM practices.

It is clear that substantial off-site damages are caused by soil erosion due to BAU agricultural production. Unfortunately, few studies take these damages back to the source and evaluate whether—and to what degree—the magnitude of the damages from BAU merits a change in land use or a shift in management practices towards SEM.

In tropical regions, many studies are explicit in targeting BAU land use per se as the cause of hydrological externalities, particularly the conversion of tropical forests to other uses. A number of these studies go so far as to include damage estimates in cost-benefit analyses to show the need for change in policies affecting land use or to justify conservation projects. For example, in a valuation of the Korup Project in Cameroon, the benefits from erosion control were estimated to be almost half of the direct conservation benefits of conserving the forest (Ruitenbeek 1990).

In sum, the results are mixed on the size of the economic impact of sedimentation caused by the conversion and modification of tropical forests. Site-specific characteristics such as geology and climate, drainage area and topography, type and size of infrastructure, and demand for end-use goods and services determine the import of conversion and modification in particular cases. The situation with other water quality factors will be much the same, namely, that the results will be mixed and that site characteristics shape findings.

WATER QUANTITY IMPACTS

The external effects of land-use change on stream flow levels will affect four types of hydrological outputs: annual water yield, seasonal flows, peak flow, and groundwater levels (Gregersen et al. 1987). These effects will, in turn, affect a host of economic activities. Consider these:

- A rise or fall in water yield or base flow will change reservoir storage and irrigation capacity, leading to changes in water supply for hydropower, irrigation, navigation, and recreation, among others.
- Change in seasonal flow levels will modify flood and low water regimes, affect the need for irrigation, and influence planning about reservoirs for irrigation, hydropower, navigation, and drinking water.
- Greater or lesser peak flows are mainly felt via change in local flood frequency; floods can damage infrastructure (bridges, culverts, roads, embankments) and agriculture (sedimentation of crop land), as well as by the extent to which homes and lives are put at risk.
- Variation in upland groundwater levels will directly influence spring discharges used for local water supplies and have downstream impacts on the productivity of local biological systems (such as wetlands) that may provide recreational or conservation benefits, as well as affect downstream agriculture and other productive systems.

The methods that may be applied in valuing such external effects are similar to those in the case of water quality, with this exception: that the value of water supply can often be found directly where water markets exist (Adams and Crocker 1991; Barbier 2007; Freeman 1993; Gibbons 1986; Gregersen et al. 1987; Kopp and Smith 1993; Young 1996). Nonetheless, the available literature on this topic of water quantity is scanty, compared to the literature on water quality effects. Only a few studies that examined the off-site costs of sedimentation also considered the attendant water quantity issues (Aylward 2004).

In Thailand's Mae Teng Basin, Vincent and Kaosa-ard (1995) employed historical data on stream flow and precipitation (two data sets not always available for humid tropic sites). With data from periods before and during the period of land use-change, the authors used regression analysis to demonstrate that:

- o No change in stream flow is observed prior to land-use change (1952-1972).
- o Dry season stream flow is reduced during the period in which land-use change occurs (1972-1991).
- o Climatological factors do not explain the reduction in water yield.

The land-use changes taking place in Mae Teng during the 1972 to 1991 period consisted of both an increase in irrigated agriculture and an expansion of pine forest plantations (typical BAU activities). Both activities can be expected to increase water use. The authors conclude that land-use change has indeed led to reduction in water yield, particularly during the dry season. However, they are unable to define to what extent each factor — conversion of land to agriculture, the use of water in irrigation, or the growth of pine plantations — was responsible for the observed decrease in stream flow.

The difficulty in ascribing causality to a particular land-use activity will complicate policy actions designed to maximize economic utility through SEM. Many of the studies reviewed show the difficulty of developing convincing hydrological analyses of the linkages between specific land uses, dry season flows, and economic production. This difficulty is particularly acute when a study site does not have a history of hydrological measurement and points to the hurdle of undertaking short-term policy-oriented studies where what is needed is long-term hydrological research or calibration of process-based models to local conditions.

Assessing Net Economic Effects of Land-Use Change

Estimating the net effect of changes in hydrological outputs on economic consumption and production is a challenge, since the same upstream action can have two or more downstream consequences, sometimes with opposing effects. For instance, suppose an additional unit of base flow into an irrigation scheme in the dry season will lead to additional output of crops by raising water availability during a critical period. If a proposed change in upstream land use will decrease downstream base flow, then one result will be lower agricultural production. At the same time, the lesser flow rate may decrease sediment delivery into the canal system, potentially lowering the costs of dredging or other remedial activity. In this hypothetical case, the two opposite effects leave the net

impact of the proposed land-use activity on downstream economic production ambiguous. Further, to understand what constitutes SEM in this case would also require understanding the on-site costs and benefits of the new land use proposed. In other words, SEM does not mean eliminating all net negative downstream consequences. Rather, SEM means ensuring that these factors enter into the decision making process. In some cases, the net harm caused downstream will not be large enough to alter landowner behavior or change their decisions.

The case with different measures of water quantity is similarly challenging; this analysis will depend on the hydrological functions that are germane to the particulars of production technology and end-use demand. For example, a change in upstream land use that leads to soil compaction and, thereby, an increase in peak flow, will adversely affect profits from a run-of-stream hydropower plant, while having no impact on a storage reservoir used for irrigation, electricity, or navigation. An increase in water yield may raise profits for a large hydroelectric reservoir, while having little to no impact on a downstream water treatment plant that is fed from such a reservoir. These results challenge conventional wisdom and, unfortunately, do not yield simple policy prescriptions. What becomes critical, in this case, is how the change in hydrological function affects installed infrastructure. Often, such infrastructure serves to buffer economic production from these impacts. In contrast, where households rely directly on rivers and streams, the effect of change in hydrological function tends to be more directly felt.

Unraveling the implications of downstream hydrological change is complex. A single hydrological output may affect a series of productive or consumptive activities, raising utility in one production process and decreasing utility in another. Similarly, a single economic production function may be affected in different ways by distinct hydrological outputs linked to a given land-use change. The possible cause-and-effect pathways are many; estimating the net effect is difficult.

A given land-use management decision may cause physical changes in various hydrological functions. These changes, in turn, will impinge on a range of economic activities, sometimes in conflicting ways. The aggregate impact on economic utility will vary on a case-by-case basis. Thus, it is not possible to generalize, for instance, that ecosystem protection or restoration is always desirable based on downstream impacts on hydrological services.

11.4 THE ECONOMICS OF HYDROLOGICAL SERVICES UNDER BAU AND SEM

The sections below provide a brief literature review on the provision of water-related ES. An attempt is made to tease out likely

generalizations, based on either the literature or economic reasoning, about the direction and magnitude of impacts under SEM for each service area.

11.4.1. Hydropower

The effects of land use on hydropower production in LAC are relatively well studied; taken together, land use and hydropower reflect a complex interaction, confounding simplistic policy prescriptions. The main question is whether negative impacts from BAU land-use practices reach a level that merits action and reversal through SEM or whether these effects are just unavoidable side effects to be reduced or avoided via changes in land management practices.

WATER QUALITY

The costs to hydroelectric generation from changes in water quality are

- The cost of generation capacity lost to sedimentation of hydropower reservoirs (Aylward 1998; Briones 1986; Cruz et al. 1988; De Graaff 1996; Duisberg 1980; Gunatilake and Gopalakrishnan 1999; Ledesma 1996; Magrath and Arens 1989; Pabon-Zamora 2008; Quesada-Mateo 1979; Rodríguez 1989; Santos 1992; Southgate and Macke 1989; Veloz et al. 1985);
- Increased dredging and maintenance costs associated with reservoir sedimentation (Rodríguez 1989; Southgate and Macke 1989); and

- Loss of power production and raised dredging costs from silting of settling ponds (Mohd Shahwahid et al. 1997)

Several early LAC studies suggested that sedimentation can have significant effects on hydroelectric power plants (Santos 1992; Southgate and Macke 1989; Veloz et al. 1985). Pabon-Zamora et al. (2008) documents the costs that sedimentation can impose on hydropower producers. This study notes the case of Peru, where some 60% of hydroelectricity produced comes from rivers in protected areas. This power generation has a value of about \$320 M yearly, while annual sediment removal from reservoirs costs \$14 M, in addition to \$5 M over 10 years to avoid sediment accumulation in protected areas. The nature of these outlays, and the link between the costs, sedimentation rates, and protected area status remains unclear. Also described are estimates that reduced sediment flowing into Venezuela's Guri dam due to upstream land management in protected areas will extend the dam's life by a decade or more.

In Tapanti National Park, Costa Rica, Bernard et al. (2009) found that upstream forest preservation has delivered benefits to hydropower facilities in two different watersheds. The value of water provided for hydropower by the park and its preserved lands is estimated at \$1.7 M annually. Combined with recreation and drinking water values, the value of the ES produced by SEM on park land is \$2.5 M/year, some \$43 annually for each of the 58,323 ha in the park. Willingness to pay for these services is estimated at \$400,000, indicating both an efficient use of lands and, more practically, a possible means to finance park administration. The park is extremely wet, receiving some 6.5m/year of rain, which feeds 150 distinct rivers flowing to the Caribbean. The park provides water for 25% of the hydropower used in Costa Rica via

Case Study 11.1. Avoided Costs of Sedimentation in Hydropower Production: Soil Conservation Measures in the Birris Watershed, Costa Rica

The life span of hydropower dams depends on the provision of adequate erosion control from upstream areas. This case study examines this concern in the Reventazon watershed, on the Atlantic coast of Costa Rica, which has been prioritized by National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) for being an important development region highly vulnerable to climate change. Indeed, current degradation of soils is determined by inadequate soil management in agricultural upstream areas such as the case of the Birris sub-watershed. Moreover, the frequency and intensity of extreme precipitation events in the region have made soils prone to more erosion. Climate change is expected to maintain or increase these trends, making necessary a call for urgent action to protect and manage soils. Erosion affects two main sectors in the watershed. Upstream, erosion affects farmers by reducing soil productivity over time. Downstream, erosion affects hydropower dams by increasing the costs for companies to extend the life span of their dams. The Reventazon watershed is one of the main watersheds for hydroelectricity in Costa Rica. The life span of these hydropower dams depends on the quality of water reaching them, which is determined by sediment loads flowing down the watershed. Each year, up to one and a half million tons are removed from the dams to ensure the longest possible life span. More than \$2 million is spent to partially remove these sediments and to produce energy by alternative sources during this operation. The Birris sub-watershed has been prioritized by the Reventazon Watershed Management Plan as one of three areas producing the highest degree of sedimentation. The quantity of sediments reaching these dams is influenced by two factors: (1) the distribution, frequency, and intensity of extreme precipitation events and (2) the type of upstream soil management.

A model of the utility of erosion control for hydropower dams was constructed. First, erosion under current landscape soil use (i.e., BAU) was estimated using the Revised Soil Loss Equation. Based on consultations with farmers, agricultural extension officers, and program representatives in the watershed, a set of practices was identified that are currently promoted and adopted in the watershed with the potential to be disseminated for erosion control. These practices were modeled in land-use scenarios to analyze their effects on erosion control in the watershed. Four scenarios were constructed: (1) BAU, (2) Reforestation of High Risk Areas for erosion control (R in HRA), (3) adoption of soil conservation practices only in High Risk Areas (SCPs in HRA), and (4) adoption of soil conservation practices in All Over the Watershed (AOW).

Scenarios 3 and 4 (soil conservation practices “in high priority areas” and “all over the watershed”) maintain the same soil uses as BAU but are characterized by changes in soil management practices (i.e., including a mix of activities from increasing tree cover to improve soil management practices in agricultural plots). Concentrating in priority areas, with either reforestation or soil conservation, brings significant reduction of erosion. In contrast, targeting soil conservation activities all over the watershed, besides being the most expensive option, brings few additional benefits in term of erosion reduction. Table 11.2 represents land-use types by scenario, the estimated investment to promote a land-use change in the watershed, and the estimated benefits accrued on-site and off-site.

This analysis of the on-site and off-site benefits of erosion control suggests that concentrating on reforestation in high priority areas is more cost-effective because reforestation requires lower investments to achieve the higher benefits. However, the valuation exercise presented in the Table 9.2 includes only hydrological services and excludes the opportunity cost of moving from agriculture to forestry in cost-terms that smallholder farmers would incur. Consultations with hydropower managers and farmers in the watershed reveal that neither group prefers the BAU scenario. This indicates a willingness to change toward improved watershed management. However, the preference of these stakeholders was not for the best alternative from an erosion control perspective (i.e., Scenario 2), but instead for Scenario 3 where there is a convergence of benefits to hydropower and farmers. Scenario 3 avoids the large cost to target soil conservation all over the watershed but significantly improves provision of on-site and off-site benefits of erosion control. At the same time, this scenario (3) allows farmers to avoid drastic land-use change and maintain their agricultural livelihood, thereby preserving the economic, social, and cultural paradigms of local communities.

TABLE 11.2. ON-SITE AND OFF-SITE EROSION CONTROL COSTS AND BENEFITS IN BIRRIS WATERSHED

	1) BAU	2) REFORESTATION IN HRA	3) ADOPTION OF SCPs IN HRA	4) ADOPTION OF SCPs AOW
Land cover types				
Livestock (Ha)	1,697.6	1,697.60	1,697.60	1,697.6
Agriculture (Ha)	1,583.54	54.88	1,583.54	1,583.54
Forest (Ha)	1,412.36	2,941.01	1,412.36	1,412.36
Soil Lost (Tons)	235,955	6,821	6,923	2,372
Costs and Benefits (Net Present Values ¹)				
Restoration Costs ²	0	1,247,383	2,212,964	3,457,897
On-site Costs of Nutrient Loss	1,238,836	35,420	35,966	13,745
On-Site Benefits of Avoided Soil Fertility Loss (vs BAU)		1,203,416	1,202,869	1,225,091
Off-site Benefits of Avoided Costs of Dredging (vs BAU) ³		807,662	1,008,674	1,024,635
Total On-site and Off-site costs & benefits of soil regulation in scenarios (vs BAU)		728,275	-37,386	-1,221,916

¹Net Present Values are calculated over a period of 20 years with a discount rate of 4.5%.

²Total start-up cost investment required to implement change from BAU to land cover/management SEM scenario.

³Annual cost of dredging 35 million colons based on estimation by JASEC (exchange rate of 580 colones/\$).

the Rio Macho, Cachi, and Angostura turbines. The intact ecosystem is known to reduce sediment flow into the generation plants; water flows from the park have sediment loads five times less than those from a river originating in a deforested area just outside the park. Economic analysis based on the different amounts of sediment arriving at each dam, coupled with removal costs, results in estimated benefits from watershed services produced by SEM on upstream watersheds in the park of \$1 M and \$614,783 annually for the Cachi and Angostura dams respectively.

Further, more disaggregated economic analysis of the Reventazon watershed (Case Study 11.1) shows that despite the apparent benefits of trying to eliminate erosion through reforestation —thereby maximizing hydrological services — the more promising alternative, once the socioeconomic impacts on local communities is included, is promotion of soil conservation measures with landowners in erosion-prone areas.

TRADE-OFFS FAVORABLE TO MAINTAINING SEDIMENTATION

Externalities associated with sedimentation are not always large or important. This condition can favor continuing with more lucrative sediment-causing activities, where benefits outweigh the costs. In Arenal, Costa Rica, present value of the cost of sedimentation from pasture (as opposed to reforestation) in terms of lost hydroelectric production ranged from \$35 to \$75/ha (Aylward 1998). The value of additional water production by pastures was greater (Section 5.1.2). In the Philippines, the effect of sedimentation from conversion of large areas to open grasslands in the Magat Basin on the length of life of the reservoir downstream was valued at under \$0.01/ha/year (Cruz et al. 1988). In Malaysia, a simulation of the effect of logging on downstream run-of-stream hydropower and treated water production indicated that a program of reduced impact logging would have essentially no effect on water supply and would lead to only a minimal disturbance of hydropower generation through sedimentation of the settling ponds (Mohd Shahwahid et al. 1997). In other words, the gains from logging could easily compensate for the losses incurred by the hydropower producer due to sedimentation. Finally, in Sri Lanka, comparison of measures for preventing or mitigating the impact of sedimentation on the Mahaweli reservoirs suggested that the costs of the measures outweighed their potential benefit (Gunatilake and Gopalakrishnan 1999).

WATER QUANTITY

Studies examining water quantity impacts on hydropower facilities are considerably fewer in number than those on water quality. In

an early review, examined were the effects of afforestation on hydropower generation in the Maentwrog catchment in Wales and 41 catchments in Scotland. This information indicates that the increased evaporation under reforestation — compared to grazing assisted sites that were financially marginal for forestry to become financially sub-marginal once hydropower losses were included into the analysis (Barrow et al. 1986). This example clearly shows a negative impact on productivity from afforestation in a hydroelectric catchment.

A study on Arenal, Costa Rica, reported similar results: water yield losses due to reforestation of pastures may lead to large efficiency losses in downstream power production (Aylward 1998). The costs associated with lower water yield were calculated to be an order of magnitude greater than those associated with sedimentation (referred to above). Subsequent research on cloud forest hydrology in the area has shown that maintaining full forest cover is unlikely to increase capture of cloud moisture or total precipitation, when compared to existing land use, which is already a mix of intervened primary forest, secondary forest, and pasture. This finding would greatly reduce the expected seasonal hydrological benefits from SEM in upper watersheds where cloud cover predominates during the dry months.

In run of river hydroelectric facilities with little to no reservoir capacity, revenues are maximized when flows are stable. Intact upstream forests are believed to contribute to these stable flows. In some cases, hydropower firms, typically those operating such facilities, have made voluntary payments to upstream landowners for watershed protection (Rojas and Aylward 2002). In Costa Rica, Energia Global, operator of two small run-of-river hydroelectric facilities offered \$10/hectare annually to upstream landowners in exchange for maintaining or reestablishing forest cover (Chomitz et al. 1999).

In sum, evidence from the literature confirms the many links between land use and the value of hydropower production. However, the pathways are complex, concurrent, and site specific. Making a blanket policy prescription on whether maintaining forested uplands — often assumed to pertain to SEM — is preferable to BAU on economic grounds is difficult. It may turn out that SEM implies adjusting and improving BAU management schemes, especially in the context of built infrastructure. While in many cases, sustainable management of headwaters ecosystems (often associated with SEM) is a better approach to mitigate the very real risks of low base flow and reservoir sedimentation, determining the utility maximizing option is not possible without information on the specific opportunity costs of existing upstream BAU land uses. The point is this: upstream-downstream relationships and economic utility on the watershed scale should be taken into account, which is the crux of the SEM approach in a broader sense.

Power generation is one of the main production processes that depend on the hydrological outputs of a watershed. Specifically, stream flow is used by hydroelectric turbines to generate marketable power. This relationship sets up a straightforward primary relationship between hydrological output and economic utility – higher flows enable higher power generation and yield greater utility. This positive core relationship between water quantity and economic utility implies that any land-use action that increases stream flow above a hydroelectric generation facility will, through this channel, have positive economic externalities. As seen above, forest conversion is generally associated with increases in annual water yield.

However, the limitations in the role of water quality and infrastructure both qualify and potentially invalidate the claim that changing forest-land use can generate hydrological benefits.

- Water quality, specifically sediment levels in inflows, can drastically reduce reservoir storage capacity. This shortens the life of a hydroelectric facility or entails costs to dredge the reservoir.
- Infrastructure limitations can also place a premium on the timing of inflows to a hydroelectric facility. In the extreme, run-of-river generation operations lack storage capacity. Dry season base flow is an important determinant of the minimum “firm” energy output the facility can produce during the year.

Given that these power plants are designed to optimize production in the current flow regime, change in land-use patterns presents risks that may not be easy to analyze. Thus, once infrastructure is installed, managers are likely to be adverse to changes in the conditions on which design was based.

A final caveat is that market demand is the ultimate determinant of economic utility. Power is worth significantly more at some times than at others. Poor timing may result in spilling water or dumping power on the market at low prices in the wet season, while later having insufficient ability to meet demand during the dry season. Watershed changes that reliably help hydropower producers to provide power at optimal times, can drive real increases in economic utility. Though the precise hydrological outputs that will accomplish this increase in economic utility will vary by case, maximizing predictability and minimizing volatility will be valuable. Managing risk is all the more important in the context of a changing climate with trends towards instability, and volatility in both flow and sediment levels, even without exacerbation by unsustainable land use.

It is clear from this discussion that the optimally-efficient upstream land use from a hydropower standpoint will be site specific, and, further, will depend on the dynamics of the watershed, the design of the hydroelectric facility, and the character of the local market for electricity. The safest course is to be risk averse and not change land

use or land management in the absence of rigorous and site-specific evidence that it will improve production. Given the indeterminate nature of water quantity impacts and the site specificity of water quality impacts, risk management with respect to hydroelectric facilities should play a central role in decision making with respect to land use and management regimes.

Irrigation

Irrigation is susceptible to some of the same effects of BAU seen in the case of hydropower. These vulnerabilities stem from direct effects on the withdrawal, conveyance, and use of irrigation water, as well as from indirect effects transmitted by changes in water storage and irrigation infrastructure. In general, the economic process is that water is applied to grow crops that are sold, thus converting stream flow, a hydrological ecosystem service shaped in part by upstream land use, to economic utility. Both water quality and quantity affect this economic process.

WATER QUALITY

The literature provides evidence of the following impacts from water quality changes:

- The loss of irrigation capacity due to sedimentation of reservoirs and canals (Briones 1986; Brooks et al. 1982; Cruz et al. 1988; De Graaff 1996; Forster and Abraham 1985; Gunatilake and Gopalakrishnan 1999; Kim 1984; Magrath and Arens 1989);
- An increase in operation and maintenance costs incurred by such sedimentation (Brooks et al. 1982; Forster and Abraham 1985; Gunatilake and Gopalakrishnan 1999; Kim 1984; Magrath and Arens 1989); and
- The hazards of irrigation using contaminated water (Qadir et al. 2008).

Reservoirs often are multi-purpose facilities where loss of storage affects both hydropower and irrigation. The results here are similar to those in the previous section on hydropower: forest conversion raises erosion and downstream sedimentation with negative economic impacts. The magnitude of these impacts will vary from one situation to another. The economic consequences vary from the extreme –e.g., major loss of reservoir capacity and operational ability –down to the nuisance level– e.g., a periodic need to remove sediment from irrigation canals.

In many river systems (e.g., the Nile, the Senegal, the Mekong) na-

tural flooding and sedimentation, historically, played vital roles in the renewal of floodplain soil fertility and delta ecosystems. Loss of these downstream services due to construction of dams or channelization of rivers has led to interest in the possibility of artificially re-establishing natural flood regimes and stream flows, so as to restore the benefits of sedimentation (the loss of which was a cost of BAU). At a basin scale, the issue of costs and benefits of natural and accelerated erosion and sedimentation under SEM requires careful assessment.

WATER QUANTITY: A FOCUS ON DRY SEASON FLOWS

With irrigation, total flow is often not as much of an issue as dry season base flow. The need for water becomes acute at the peak of the dry season; irrigated agriculture will clearly benefit from predictably higher base flows in the dry season. As with hydropower generation, the timing and quality of water flows determines the actual value of these ecological services (and, thus, also the costs and benefits of the upstream land-use regime that shapes them).

What is the potential role of land-use change under BAU or SEM on dry season base flow and on related ES? Only a few economic studies have attempted to quantify the enhanced groundwater storage and subsequent dry season base flow often supposed to be benefits provided by forest cover (Brown et al. 1996; Pattanayak and Kramer 2001a, 2001b; Richards 1997). Most of these studies suffer from difficulty with the direction and magnitude of the land-use and hydrological relationship. Two opposing dynamics determine how land-use change affects these flows: (1) forest preservation can increase infiltration and groundwater recharge to support dry season flows, but (2) the greater plant cover also raises water loss via evapotranspiration (Bruijnzeel 1990). Most experimental evidence suggests that the evapotranspiration effect predominates in forests (but not in other vegetative cover), leading to lower base flows. That said, there are exceptions in which base flows increase under forest conditions: cases where severe soil compaction lowers infiltration rates sufficiently or where changes in evapotranspiration are minimal. The problem with these studies concerns this claim: that base flow increases were either based on questionable hydrologic analysis or merely on the assumption of a positive correlation between forest cover and base flow. Caution is, therefore, required in interpreting their findings.

In addition, expected economic impacts may or may not be relevant in a given situation, due to variations in irrigation practice and infrastructure. If a large storage reservoir is available, then, high peak flows can be captured for later use and low base flow may not result in scarcity of water for irrigation. Sedimentation may or may not harm or limit infrastructure, depending on the design of reservoirs and canals, and the use (or not) of sprinklers, drip systems, and other hardware.

The message of these various drivers for the land-use planner will be contextual and site specific. The principle question will be whether under a shift in land use (say to SEM), the constellation of changed hydrological functions of the watershed will be balance positive or balance negative in their impact on irrigated agriculture. If a transition to SEM yields benefits in terms of reduced volatility of flows, control of sedimentation, and higher base flow, as seems plausible, then the next consideration is whether the benefits are worth the opportunity cost of the changes. As with hydropower, the complexity of the production process and importance of local conditions make simple policy prescriptions difficult. Once again, risk management tends to become a dominant element in decision making.

Drinking Water Supply

WATER QUALITY

The relationship between land use, ecosystem management, and water supply is largely portrayed in the literature as an issue of clean water. The largest set of studies deals with erosion and sedimentation impacts. These studies focus on increased costs of water treatment associated with sedimentation, but only a few studies quantify these costs rigorously. A number of studies show significant external effects.

As noted above, Clark et al. (1985) estimates damage from off-site impacts of soil erosion in the U.S. at \$15 billion, not counting the impact of erosion on biological systems and the economic activity from these systems. The Clark study covers not just erosion and sedimentation, but more general water quality problems, including the effects of agrochemicals. Water treatment costs due to soil erosion in the U.S. are estimated at \$245 million/year. A further \$900 million yearly is estimated as the impact of dissolved solids on municipal and industrial water users. These estimates by Clark et al. (1985) dramatize the potential size of the off-site damage caused by soil erosion and poor water quality. Holmes' study (1988) of country-wide costs of erosion to the U.S. water treatment industry gives a range of \$68 million to \$2.7 billion/year, with a best estimate of \$685 million — almost three times larger than Clark's figure. Despite greater sophistication, Holmes' methods give a wide range of estimates, reflecting continued uncertainty over the true magnitude of erosion damage.

Few comprehensive valuation studies of the kind noted here (Clark and Holms, particularly) have been published for developing countries. However, these studies are worth inclusion here: An unpublished study from Costa Rica compares water treatment costs in forested and deforested watersheds, finding that these costs are higher in the deforested watershed (CCT and CINPE 1995). However, this cost is just \$0.0004/m³. That would amount to just \$0.01/month per

household in the deforested watershed (Rojas and Aylward 2003). The extra water treatment costs are just 8% of the cost of protecting a forested watershed, calculated in the same study (Rojas and Aylward 2003). This finding suggests that forest protection may not be the optimal solution in this case—obviously, other factors would also have to be considered as well.

In Santa Catarina, Brazil, 106,000 farmers adopted improved land management practices on 400,000 ha in over 500 micro-watersheds. While this World Bank project aimed to increase crop productivity — and did, realizing a 20% rate of return (Postel and Thompson 2005) — the SEM practices used also led to improved water quality. For example, in the Lajeado Sao Jose watershed, domestic water for the city of Chapeco had large decreases in turbidity, suspended sediment, and fecal coliform bacteria. This lowered the cost of chemicals used for municipal water treatment. Savings were enough to have paid for the upstream erosion control measures in just four years (Bassi 2002). This sort of cross-sector synergy is feasible under SEM.

A study of the Tapanti National Park in Costa Rica valued ES provided by intact upstream land cover at \$200,000 annually in terms of drinking water, in addition to the significant benefits to hydropower that were similar to those reported in the case of Lajeado, Sao Jose watershed (Bernard et al. 2009). Having contrasted sediment loads from park watersheds with those from neighboring deforested basins (1:5 ratio), the authors used the cost of reactants to treat water to value the water quality provided by the park. They found annual savings of \$169,470 at one treatment facility and \$30,100 at another. With hydropower and tourism benefits, the total value of watershed services was estimated at over \$2.5 million/year.

PAYMENTS FOR ENVIRONMENTAL SERVICES (PES)

Examples of payments for ES are consistent with SEM being economically feasible as a water quality risk mitigation strategy, even if actual quality impacts remain difficult to measure (Wunder and Alban 2008). The municipality of Pimampiro, Ecuador (pop. 12,951), established a scheme to pay landowners to protect native vegetation in the watershed of the Palaurco river. The aim was to protect water quality and dry season water quantity in the river, which supplies the town's domestic water. Payments to upstream landowners were financed by a water endowment and a 20% surcharge on water consumption for the 1,350 families using the municipal supply. The scheme has been economically viable — aggregate payments consistent with municipal willingness to pay (WTP) are sufficient to compensate upstream landowners for their contribution to ES (payments were as much as 30% of annual income for some upstream households). The scheme has been justified as a risk mitigation effort, in the assumption that allowing alteration of the upstream landscape entails significant risk.

Yet, lack of information on the hydrological relationship between land cover and water quality/quantity means that the size of the risk and the true value of any risk mitigation is difficult to estimate.

A Guatemala case uses a linear programming approach to estimate the willingness of downstream households in the town of Coban to pay for better water quality and quantity at about \$13,000 in the aggregate (Manez Costa and Zeller 2005). Mapped to the upstream watershed of the Mestela River, the town's water source, this amount translates to \$15 per month per upstream household. Unfortunately, efforts to compare this amount with the opportunity costs of conversion to upstream SEM were inconclusive. Though some possibility of gains from a change to SEM was thought to exist, poor information on the marginal impact of a particular land-use change on downstream water services was expected to hinder implementation.

A study of watershed ES in the cloud forest watershed of La Antigua in the Mexican state of Veracruz further corroborates the correlation between intact upstream watersheds and water quality (Martinez et al. 2009). The study found that when previously forested mountains are logged and converted to coffee production, grazing, and sugar cane plantations, water quality generally decreased on a continuum from cloud forest to coffee plantations, with grasslands falling in between. A PES scheme was conceived to encourage protection of water quality by SEM, but initial efforts found that payments were insufficient to fully compensate landowners for the opportunity cost of foregoing land conversion. The question of whether the value of the ES exceeds the opportunity costs was not adequately explored. Few, if any, of the developing country studies provide detailed investigation of the BAU vs SEM issues. Nor do these studies suggest that the value of water quality improvements to be gained through SEM is terribly large. However, they do reflect growing interest in and initial investigation of these topics in LAC countries.

WATER QUANTITY

A single published study linked land use to change in water quantity and water supply. This study provides a counter example to the trend established above. The authors assess the effect of harvesting old-growth Eucalypt forest in Victoria, Australia, on ecological services (Creedy and Wurzbacher 2001). The trees have the unique property of transpiring very little water. The effect of harvesting and allowing regrowth of this forest stand is a decline in annual water yield, not an increase as might otherwise be expected (Vertessy et al. 1998). Creedy and Wurzbacher do not estimate hydrologic service values per hectare; but, they do show that balancing the costs of alternative sources of water against the benefits of logging leads to the conclusion that logging is not worth the costs this activity incurs in terms of water supply.

DISCUSSION

The paucity of efforts to connect SEM and water quantity to water supply may reflect the fact that water supply is typically a minor use of water resources compared to other uses, particularly agriculture. Still, there remains the popular perception that a tree-covered watershed above a city assures additional water supplies. As discussed earlier, the relevant value of switching to SEM is likely to be protection of water quality. The magnitude of any benefits will obviously vary with the associated land-use and management practices. In the extreme case, the impacts of deforestation could be catastrophic. However, as related above, in many cases, the existence of water treatment facilities means that, typically, marginal improvements in SEM will only produce minor benefits. Degrading small, protected watersheds above the drinking facilities of major metropolitan areas runs the risk of loss not

only of hydrological services but also of a series of other aesthetic, cultural, and recreational values. Judging which benefit dominates is probably not as important as showing the overall risk to public facilities and public health.

Ancillary Water-Related Services

FLOOD CONTROL

Impacts on flood control include an extension of the impacts of sedimentation on reservoirs, in the form of the loss of flood control benefits due to reservoir sedimentation (De Graaff 1996). Other studies

Box 11.2. Panama Canal Watershed Management

The Panama (Intercarib S.A. and Nathan Associates 1996) study generated scenarios on how land management in the Panama Canal watershed determines water and sediment inflows to the dams, and water supply to the locks over a 60-year planning horizon. Resting on the valuation effort, hinged the prospect of developing a third set of locks for the Canal, at which point, the current water storage capacity would be insufficient, with a water shortage anticipated by 2020. The study examined (1) the building of additional dams to supply water and (2) the effects of massive reforestation. The benefits of erosion control through reforestation in the Panama Canal Zone is estimated at a present value of just \$9/ha in terms of its effect on storage reservoirs and water supply for navigation. This figure is quite low compared to the anticipated costs of reforestation. Additional technical studies later showed that sedimentation levels in the Canal basin have dropped almost back to background levels given that land use stabilized in the 1990s, following considerable deforestation during prior decades (Stallard 1997).

The study goes on to calculate the benefits of water storage offered by 132,000 hectares of existing forests. The storage was estimated to be an additional 1,500 m³/ha/yr based on hydrological analysis. The study reports water storage benefits for these existing forest areas as \$277/ha in present value terms. The same figure is then used in calculating the water storage benefits of reforesting an additional 100,000 hectares in the Canal basin. The resulting benefits are expected to be \$36 million. However, assuming that the new dam would not need to be built until 2020, the present value of such a figure would be more in the region of \$3 million than \$36 million. In all likelihood, then the hydrological benefits of engaging in massive reforestation of the Panama Canal basin due to both water storage and erosion control were overstated in this study. More recently, and after exhaustive assessment of a large number of alternatives, the Panama Canal Authority decided to provide water to the third set of locks by re-capturing the water released as ships exit the locks and pumping it back up into the canal. In this case, an engineering/infrastructure solution prevailed over an ecosystem approach.

This result was probably warranted given that the study had only limited hydrological evidence to support the water storage claims. The approach relied on a “paired” catchment analysis that does not have an experimental basis —i.e., calibration followed by treatment (Intercarib and Nathan Associates 1996). Instead, monthly stream flow data for six forested and cleared catchments (three each) are compared based on twenty-one years of data. The data suggested that monthly stream flow, measured as a percent of total precipitation, is less responsive in the case of the forested catchments. The authors use this information to claim this: land that remains in forest cover stores a larger amount of water going into the dry season. This capacity is then available to “refill” the dams in the dry months.

As with many efforts of this nature, the potential existence of confounding variables cannot be ruled out. Further, the study ignores the potential decrease in annual water yield that presumably would result from reforesting cleared areas of the Canal basin. Thus, the study emphasizes one type of hydrological change and ignores another, in addition to falling short of providing firm evidence of the hydrological effect that is subsequently used in the valuation exercise.

portray utility as a decreasing function of BAU. The effect can be location specific, with appreciable reduction in flooding from intense storms most likely in small forested watersheds, because larger basins see an averaging effect on discharge as storms pass. (Landell-Mills and Porras 2002).

Richards (1997) examines the potential benefits of a flood control program in the Taquina catchment in the Bolivian highlands. Damage costs from a recent flood are used to estimate future ones. Assumptions regarding flood frequency and intensity are made under both the “with” and “without project” scenarios. By year five, the flood control benefits are calculated to outweigh project costs by threefold. While the benefits appear quite large, it is not clear to what degree these benefits are a response to land-use change in terms of on-farm soil conservation as opposed to the effect of hydraulic works and mitigation infrastructure located in gullies and stream courses. Here again, management practices may mask the effects of land-use change.

None of those studies applies the standard methodology for projecting flood damage as recounted by Gregersen et al. (1987). Under the Gregersen methodology, flood frequency curves (the probability that a given streamflow level or stage height will be exceeded) are developed for the “with” and “without” project scenarios. A damage function is then developed that relates peak flow levels to damage costs. A practical difficulty in applying this technique in developing economies is the poor availability of historical data on damage by past flood events. This problem is exacerbated by rapid urbanization, industrialization, and population growth, which make the relationship between peak flow levels and damage costs unreliable over time. In LAC generally, the link between land-use change and flood risk is imprecisely defined.

NAVIGATION

The impact of land management on navigation include the loss of shipping opportunities associated with sedimentation of reservoirs used to supply water to canal locks in Panama (see Box 11.2) and the increasing dredging costs associated with harbor siltation in Indonesia (Magrath and Arens 1989). In the Panama case, the benefit of erosion control through reforestation in the Panama Canal Zone was estimated at just \$9/ha in terms of its effect on storage reservoirs and water supply for navigation. This figure is quite low compared to the anticipated costs of reforestation. Additional studies later showed that sedimentation levels in the Canal basin dropped almost back to background levels when land use stabilized in the 1990s, following substantial deforestation during earlier decades (Stallard 1997).

TOURISM AND RECREATION

There are some studies on the tourism and recreation value of watershed services in LAC. To the extent that this value is (a) indeed related to the hydrological services provided by an area and (b) these services are enhanced or protected by SEM practices, then there may be a case for SEM as an economic policy. As with many other areas, site-specific economic conditions and partial data are a common obstacle. Since the benefits of tourism associated with SEM are covered in detail elsewhere in this volume, a few examples here will suffice.

A contingent valuation approach was used to estimate visitor willingness to pay toward preventing conversion of Costa Rica’s Monteverde Cloud Forest Preserve to agriculture (Echeverria 1995). The study found that the value of the intact preserve was higher than the opportunity cost of foregone agricultural profits. Consumer surplus of \$2.3 million for the 32,213 annual visitors (in 1991) was translated to a net present value of \$37 million. While this valuation study is supportive of continued landscape preservation, the finding does little to inform management decisions at the margin. For instance, is reforestation of agricultural lands worth the costs?

A study in Costa Rica values annual tourism and recreation benefits at \$657,500, based on entrance fees at Tapanti National Park and net income to tourism-related businesses, including white water rafting (Bernard et al. 2009). While this figure is only a portion of the value of ES related to the park, the recreation and tourism value alone exceeds park management costs. Despite this finding, it is unclear whether restoration of adjacent deforested lands would yield parallel tourism-related economic benefits.

A study of the value of coastal ecosystems used a value transfer methodology to conclude that \$3.2 B is delivered annually to local citizens in Catalonia, Spain (Brenner 2009). The bulk of the value was related to intact beaches in an area with a large tourist industry. While these value estimates have limited applicability to the LAC context, the concept of high values for coastal ecosystems attractive to tourists raises the question: to what degree do SEM and hydrological services support these coastal values?

In this regard, it is relevant to cite an early study from the Philippines showing that logging of a coastal catchment may increase sedimentation of a coral reef downstream (Hodgson and Dixon 1988), with negative effects on coral cover and diversity. Since both coral cover and diversity are implicitly assumed by the authors to enter into an ecotourism production function, the knock-on effect of the change in hydrology is negative for this economic value. At the same time, the loss in coral cover has a negative impact on the biological production function for fish in the area. Fish, in turn, are a key input in the fishing production function, which is also adversely affected

Box 11.3. Valuation of African Wetlands

In the Barotse floodplain in Zambia, the value that local residents capture from intact wetland ecosystems is estimated at \$8.6 million/year (Emerton 2005). Some 225,000 people reside in the floodplain of 5,500 km². Residents spend the dry season in the floodplain; farming, grazing, and fishing are key economic activities. This status quo was compared with conversion to large scale agriculture. The cost to locals of converting wetlands to agriculture was estimated at \$1.2 million–\$3.0 million, in addition to potentially extreme negative downstream effects. Little information was included on the benefits of alternative uses of the wetlands.

Acharya (2000) confirms that intact wetlands provide significant economic value beyond the direct-use values typically captured in market transactions. Using the case of Nigerian wetlands, this study explores how environmental linkages drive hydrological services and how these interact services with the economy. A welfare economics approach is used, where the value of changes in environmental resources and services is derived from measuring the effects of these changes in human welfare.

The Hadejia-Nguru wetlands are fed by the Hadejia and Jama'are rivers, which experience concentrated runoff in August and September but limited stream flow for the rest of the year. The wetlands are important for wildlife and support economic activities including grazing, agriculture, fuelwood collection, and forestry. Upstream irrigation schemes are being constructed and will deprive wetlands of some water. The present value of wetlands is calculated as between 846–1276 Naira per hectare.

Through a two-part analysis, the study examines the value of groundwater for dry season agriculture and value of groundwater for domestic water consumption. A hypothetical groundwater recharge rate change was estimated in terms of its impact on these two uses. The valuation was based on a one-meter decline in water table levels, in-line with projections from proposed upstream projects. Using this approach, the total loss associated with a 1m changes in naturally recharged groundwater levels is estimated at 383,642 Naira or \$4,360 for the study area. The study establishes a positive value to the groundwater recharge function that should be considered when weighing upstream development of wetlands. The author points out that this value estimate really constitutes a lower bound, because many other key background factors are not included; this point is important: if there were no groundwater, entire populations might have to relocate (Acharya 2000).

by logging and subsequent change in catchment hydrology. Despite this early study, few examples have been developed since addressing how SEM and hydrologic function can contribute positively to coastal tourism and fisheries values.

WETLAND FUNCTIONS

The economic value of wetland ecosystems and the relationship of that value to different management approaches has much in common with the hydrological services described here (see, for example, Box 11.3 on valuation of African wetlands). A single example from Latin America was found: an analysis of the hydrological externalities of agriculture development in the Esteros del Ibera wetland in Argentina (Simonit et al. 2005). In the 12,000 sq. km. wetland, a hydro-power project and significant rice production contribute to ecosystem stress. The Yacyreta dam, jointly constructed by Argentina and Paraguay, has expanded the wetland. The current water level of the reservoir is three meters above the original wetland; the final water level will be 10m above this original wetland level, once the reservoir is full. The higher water level has increased the scope of the wetland

and provided additional water for irrigated rice production. Significant ES and external values were excluded from the study, rendering a holistic economic assessment difficult.

More generally, a meta-analysis of wetland valuation literature provides some insight into the value of wetland function (Brander et al. 2006). Based on a data set of analyses heavily weighted toward North America, Brander finds that average values for wetlands greatly exceed median values due to few, high value cases. South American wetlands were seen to have the lowest value, when compared to wetlands on other continents, though this observation is unsurprising given the strong relationship between income and value estimates. A log-linear meta regression found a positive, elastic relationship between per capita GDP and wetland value, along with a positive, inelastic relationship between population density and wetland value. Large wetlands were found, on average, to be less valuable per hectare.

In sum, insofar as wetlands are concerned, site-specific conditions are yet again the rule, with limited information on benefits and costs of various management approaches making generalization difficult. Nonetheless, a literature review points to several primary dynamics:

- Water development and diversion to irrigation, hydropower, and

other uses can reduce the extent and functionality of wetlands by reducing the availability of water;

- Reservoir development and drainage for agriculture can directly impact the extent of wetlands by displacing or converting landscapes; and
- Wetland conversion, typically, imposes costs of lost ES such as fisheries, plant products, grazing, and floodplain agriculture (Acharya 2000; Emerton 2005; Simonit et al. 2005), but it is difficult to say whether costs of conversion projects outweigh the benefits (Beaumais et al. 2007).

has consequences for activity downstream — effects routed through hydrologic services. Alterations to watersheds have enabled human populations to flourish and have provided important welfare-enhancing services to society; but watershed alterations also have caused negative side effects. Using SEM approaches to optimize utility from hydrologic services on a watershed involves careful balancing of the costs and benefits from built and natural infrastructure. The task facing decision makers is not just recognizing that ecosystem function affects human welfare but integrating this understanding into policy.

Both challenges and opportunities are associated with developing and implementing policy responses with respect to hydrological services. A brief survey of the responses available to the policy community — defined broadly to include government, business, and civil society— is followed by a review of the principal incentive mechanisms that have emerged in watershed management, especially in LAC. Payments for ES (PES) are in the forefront. The use of PES is reviewed in the context of watershed management and hydrological services. This section closes with examples from the region of some typical watershed management problems encountered and solutions being implemented.

11.5 POLICY AND DECISION MAKING OPTIONS: MOVING TOWARD SEM

Land and water resource development has had both favorable and adverse consequences for ecosystems and the economy through modification of natural hydrological systems. In the case of watershed management, this has meant that economic activity upstream

TABLE 11.3. POLICY RESPONSES AND INCENTIVE MECHANISMS

CATEGORY	SUB-CATEGORY	WATERSHED EXAMPLE
Public Ownership	Public Operation	National Forests
	Private Operation	Timber concessions; conservation easements
Public Investment	Appropriations	Pollution control; Dams
Regulations (Command & Control)	Technology Standards	Waste discharge control equipment
	Performance Standards	Discharge concentration limits, bans
Market-based Instruments	Taxes, Charges and Payment in Lieu	Tax on stream flow reduction
		Water Funds
		Wetland payments in lieu of mitigation
	Subsidies	Reforestation tax credits Payments for avoiding deforestation, following land and undertaking best management practices
Regulated Markets	Tradable Permits	Temperature, nitrate and salinity credit systems
	Payment in Lieu	Wetland banking
Voluntary Actions and Markets	Buyer-Seller Contracts (true PES)	Payments for Ecosystem Services
	Voluntary Offset Credits	Water
	Product Certification	SEM Shade coffee
	Philanthropy and Donations	Funding for range of actions

11.5.1 Policy Responses for Hydrological Services

The case of an upstream farmer not taking into account the effects of land-use decisions on water users downstream (in terms of water quality, for instance) can be seen as a classic case of public goods and market failure. To resolve these problems, a variety of entities typically promotes SEM in a watershed — in the sense that they attempt, through regulation, provision of incentives, or cajoling, to persuade a number of actors to manage their land, water, and other resources without externalizing costs. Meanwhile, individual actors focus on the costs and benefits of managing the natural resources that are under their control. SEM, then, implies a need to coordinate the actions of a range of different entities, from farmers to industrialists to protected area managers. SEM is, thus, a collective action problem, with good watershed management revolving around the search for ways to ensure that changes in downstream (off-site) hydrological services are included into the decision making process of the land manager —who will otherwise consider only the costs and benefits of the on-site hydrological services. Watershed management, as described in this case, may mean developing mechanisms to alter the incentives facing the land manager to balance on-site productivity and lower externalized downstream costs, such as for water treatment.

A number of approaches can structure incentives to improve management of public goods such as water:

- Public production, in which government acquires an ownership interest and proceeds either to manage the watershed directly or outsource watershed management to entities under its influence;
- Public investment, in which the government funds entities to engage in watershed management;
- Regulation, in which technical or performance standards are set so that all actors must abide;
- Market-based incentives, positive (subsidies) or negative (taxes, fees), are set with landowners, utilities, and others left to decide how much and what kind of watershed management to provide;
- Regulated markets, under which several instruments are designed: caps on resource use or pollution are set; and tradable permits for water, water quality, and other measurable services are issued to users or polluters. Then, market participants are left to make an efficient allocation of the costs and benefits of resource use; and

Case Study 11.2. Environmental Services for the Energy Sector in the Dominican Republic

The Dominican Republic has announced a move toward SEM that represents an example of cross-sector synergy, involving national energy strategy and hydrological services. The Enterprise for Hydropower Generation (EGEHID) has undertaken an investment plan to assure provision of water for hydropower to reduce dependency on imported fossil fuels (under BAU). Important savings are expected because large gains can be had by switching energy generation to hydropower from thermal plants. Currently, 84% of energy production comes from fossil sources; only 15% is from hydropower: 1,376 Gwh/year out of 9,000 Gwh/year). Even with a projected increase in gas-based generation, the total power supply will be insufficient to meet the growing demand in the Dominican Republic.

The plan includes construction of other hydropower plants to add 2,550 Gwh/year to existing capacity over 15 years. Savings obtained by increasing hydropower generation would reach \$10 million yearly based upon an oil price of \$80/barrel. The plan also includes a technical assistance program for the energy sector with watershed conservation as a main component, funded by the government and a World Bank loan. This watershed protection component is basic since watersheds have been deteriorating, negatively affecting water availability for consumption, agriculture, tourism, and energy.

The watershed management program has prioritized interventions — based on an analysis of land use, slopes, and precipitation patterns — in watersheds holding 25 hydropower plants that cover 18% of the territory (8,807 km²). Actions to protect watersheds include changes in land use on private lands and public protected areas. The three components of the program are (1) institutional capacity of EGEHID, (2) investments in priority areas based on their potential vulnerability, and (3) a monitoring and evaluation scheme to assess results and modify actions. The investment needed for the watershed management plan is \$35 million for five years. The cost of implementing the plan ranges from \$0.002 to 0.005 /Kwh produced, small compared to the price of energy and more than compensated for by the economies generated by the switch from fossil fuels. Investment began in 2010, based on a set of policies put in place previously that include provisions for sustained, self-financing public investment, an improved regulatory environment, and market-based incentives.

- Voluntary (non-regulatory) actions and markets, in which civil society, business, and/or public agencies agree on incentive or social responsibility programs for buyers and sellers of watershed services.

Examples of these mechanisms as applied to ES and watershed management are shown in Table 11.3.

Several of those mechanisms have been used to promote SEM in LAC watersheds. Examples include:

- *Public Purchase of Land* to protect valuable ecosystems, mainly forests, where water resources are generated. This is the case of Cuenca, Ecuador, where the municipal water utility has bought 8,000 ha to be added to public protected areas in the region (50,000 ha); similar land acquisition by water user associations took place in Campo Alegre and Valle del Cauca in Colombia.
- Twelve municipalities share in *Public Ownership and Investment* in the Ayuquila River Basin in Mexico, with funding from the Federal Minister of Environment and the Jalisco state government, to reduce river pollution and promote sustainable development. The innovative part of this initiative is the association of several local governments to restore environmental quality within and across their administrative boundaries, incorporating academic and civil society entities (Graf-Montero 2006).
- *Public Investment*: For decades, the region has seen watershed management projects implemented with host country and donor funds. A recent example comes from the Dominican Republic, where decision makers have committed \$35 million to provide hydrological services to hydropower facilities across the country. At \$0.002 to \$0.005/Kwh, the cost for sustainability of the program is significant, but within the scope of energy prices broadly speaking (see Case Study 11.2).
- With respect to *Regulatory Interventions*, mandatory standards for technology and performance are seldom considered for the design of watershed management schemes in LAC; however, some standards are promoted by PES schemes, mainly by technical assistance and training for participants. Standards refer mainly to agricultural and forestry practices, as in the cases of Valle del Cauca and Fuquene in Colombia; Energía Global, Platanar, CNFL and the National PES program in Costa Rica; Cuenca in Ecuador; Los Negros in Bolivia; Pasolac Initiatives and Ecoservicios in El Salvador; and San Jerónimo in Guatemala. Adoption of those practices or of certain technologies can, thus, be achieved as an integrated outcome of PES transactions, rather than by official fiat.
- *Market-based Incentives* in LAC are dominated by PES schemes that provide subsidies to landowners or managers to maintain

forest cover or engage in reforestation or sustainable forest management. These PES schemes are financed at various levels, from national agencies to local municipalities. The funds are sourced typically from fees or charges on resource use, such as the tax on fossil fuels in Costa Rica or the water fees paid by large municipal and industrial water users in Mexico.

- *Voluntary Actions and Markets*: In a few cases, pure PES schemes exist through which the beneficiaries of watershed management activities pay upstream landowners to manage their lands in ways that contribute to the production of hydrological services.

PAYMENT FOR ECOSYSTEM SERVICES

Payment for ecosystem services (PES) is increasingly an important facilitator for SEM watershed management in the LAC region. In 2008, there were at least 36 active schemes with annual funding of \$31 million (Stanton et al. 2010). These investments were protecting 2.8 million ha. National and local governments play an important intermediary role. Most funding comes through national level schemes where financial participation is not voluntary, but based instead on taxes and charges. For instance, the national PES scheme in Costa Rica is partly funded by a fuel tax that is subsequently allocated among ecosystem service priorities: forestry conservation, watershed protection, carbon sequestration, landscape beautification, and biodiversity protection (Chomitz et al. 1999; Grieg-Gran et al. 2005).

Characterizations of PES abound (Aylward 2007; Pagiola 2002; Porrás et al. 2008; Swallow et al. 2007; Wunder 2005). While many distinctions can be made, the most important variation between schemes has to do with financing mechanisms. Funds for PES come from a gamut of sources: government, public and private utilities, NGOs, user groups, and individual donations. In some schemes, funding is voluntarily; in others, funding is via a mandatory charge or tax. Sometimes the entity raising the money is a direct beneficiary of the ES provided, and other times not. A further distinction, particularly in the case of payments by utilities (water services, hydropower producers, and irrigation associations) is whether the funding decision is made at the level of the utility or is put directly to the end users or customers. As shown in Table 11.4, there are examples of PES from LAC that range across the full spectrum of financing types, showing that the region has been an important locus of PES experimentation and implementation.

Despite the prevalence of centralized promotion of PES, there is a growing number of decentralized (municipal) schemes that appear to give more effective results (Wunder and Alban 2008). In these cases, typically a public entity or a water utility collects the funds and

Case Study 11.3. Payment for Environmental Services: Pimampiro, Ecuador

In Pimampiro, farmers receive payments to maintain natural forest cover and ensure clean water supplies. These payments are intended to discourage activities that have historically damaged the environment and degraded water quality, such as slash-and-burn agriculture, timber harvesting, and cattle ranching. The municipality of San Pedro de Pimampiro is a small town in the Province of Imbabura in northern Ecuador, on the Pisque watershed, which feeds the Chota River, Imbabura's main water source. The region has a history of water shortages, exacerbated by pollution of available water by agricultural runoff. Pimampiro is protecting the watershed primarily to ensure that residents and industries have access to adequate clean water. Pimampiro is also interested in preserving biodiversity because the area is a buffer zone for the Cayambe Coca Ecological Reserve. The region has indicator plants that only grow with an ample water supply. The presence of certain megafauna, such as the Andean bear, is also a signal about the stability of important indicator species.

In 2001, the municipality established a pilot project entitled Water Regulation for PES for Forest and Páramo Conservation. The equivalent of \$15,000 was allocated to subsidize this project. The local government collects an additional \$500/month in water fees. Approximately 1,350 households and businesses pay an annual fee of \$0.96 and \$2.16, respectively, for the use of 17 m³ of potable water. The funds are then distributed to members of the Nueva America Autonomous Association for Agriculture and Livestock (NAAAAL), located in the parish of Mariano Acosta, 32 km upstream from Pimampiro. In 2004, 20 of the association's 24 members received payments for preservation of about 300 ha of forest. Association members get from \$11 to \$16/ha/year. Payments are made quarterly and vary by land category. From January 2001 to September 2002, \$6,871 was paid to NAAAAL members.

Based on the Pimampiro experience, IIED (2004) suggests that a tax managed by municipalities can benefit the poor while leveraging funds for environmental protection. More information is needed on the hydrological functions of particular ecosystems and the value of ES to foster replication of similar projects elsewhere.

The Pimampiro program succeeded, in part, because outside actors ensure direct channeling of payments from buyers to sellers. The program is overseen by Desarrollo Forestal Comunitario via a subsidiary, CEDERENA, and the Inter-American Foundation. In addition to providing for payment, these organizations help to plan activities such as agroforestry and soil conservation, facilitate community organization, and promote municipal action.

Ecuadorian law does not give water rights to landowners. Since the agreement cannot mandate that farmers maintain water quality, the city runs the risk that the Association will fail to comply with its terms. Control over natural resources is usually needed for PES programs; this one is successful due to the willingness of NAAAAL members.

pays service providers; this role may also be assumed by NGOs or water user associations. In fact, most PES financing is hybrid since this financing depends not only on water use fees but also on public funding and NGO contributions (Wunder et al. 2008). These water funds are also, typically, funded through taxes and charges on water users, mainly households and farmer associations. These water funds also require the municipality or the water agency to charge an extra fee for water conservation and then allocate the resources among direct payments, in-kind transfers, or conservation projects. Initiatives such as Pimampiro in Ecuador, Coahuila in Mexico, Otoro in Honduras, San Pedro del Norte in Nicaragua, Heredia in Costa Rica, Pasolac Initiative and Ecoservicios in El Salvador, and Cerro San Gil in Guatemala are all examples of PES with direct cash payments to service providers (IIED 2010; Kosoy et al. 2007). The Pimampiro and Coahuila cases detailed in Case Studies 11.3 and 11.4 are an example of how many of these smaller scale initiatives are implemented.

The Water Fund (FONAG) of Quito and the cases of Cuenca in Ecuador, Tarija in Bolivia, Valle del Cauca in Colombia, and the PCJ Consortium in Brazil have implemented the funding of conservation projects instead of cash transfers to service providers. In-kind transfers have included agricultural inputs in Fuquene and tree saplings in Plan Verde in Colombia, water infrastructure in ICO Water Planting in Bolivia, and beehives in Los Negros in Bolivia (Asquith et al. 2008; IIED 2010). Technical training on agriculture and forestry practices has been promoted in Sierra de las Minas in Guatemala, Quito in Ecuador, and with Silvopastoral in Colombia, Costa Rica, and Nicaragua (IIED 2010). Microcredit is another benefit provided by PES schemes in Cuenca in Ecuador, and Valle del Cauca and Fuquene in Colombia.

There are also experiences in the region showing the importance of water-related industries, such as hydropower generation and water bottling, as parties to PES schemes. Energía Global, CNFL,

Case Study 11.4. Payment for Hydrological Services: Zapalinamé, Coahuila

In the Sierra de Zapalinamé Reserve in the state of Coahuila, Mexico, mountain streams provide clean water for more than 70% of the nearly 700,000 residents of the city of Saltillo, as well as for those of neighboring Arteaga and Ramos Arizpe. In addition, the Sierra supports habitat for endangered species such as the puma and the maroon fronted parrot. In 1997, the Reserve was declared a nature reserve, but as more and more people moved into the mountains and farmers worked the land more aggressively, the effectiveness of the natural catchments that regulate and filter the water has been diminished.

Conditions in the watershed are improving due to actions to protect it, including a PES scheme launched in 2003 by an NGO consortium including the Mexican Fund for Nature Conservation and the Gonzalo Río Arronte Foundation. The NGO Profauna launched a public awareness campaign to increase resident recognition of the importance of the Sierra as their water source. Saltillo water users contribute a voluntary fee for conservation of the Reserve and the ES it offers. The fee is collected via water utility bills, after which the fees are passed on to Profauna to finance management of the reserve and community projects.

The scheme allows Saltillo residents to pay landowners in the Reserve to act as guardians of the watershed, providing funds for sustainable management. The voluntary nature of the PES scheme fosters active participation by residents of both the city and the Reserve in protection of their natural capital. Contributions vary from one to 1,000 pesos; 88% of pay less than 6 pesos per month, while only 2% pay 15 or more. Only about 10% of 160,000 water users presently contribute, but engagement is growing and amounts collected are on the rise: in the first year of operation, total contributions amounted to about \$3,000, whereas by 2006 contributions had risen to \$50,000.

In 2006, the state of Coahuila increased support of the program with a matching arrangement. In addition to his personal contribution, the Coahuila Governor committed to double the resources for the project. In the long term, the program's success depends upon its impact on both the environment and the communities of the watershed. Monitoring of springs in the upper basin is done every two months to track water quality and flow.

Platanar, La Esperanza, and ICE in Costa Rica are examples of hydropower producers that depend on water quantity and quality to minimize operation and maintenance costs. They engage in PES mechanisms to compensate ES providers (IIED 2010). Similarly, Florida & Ice Farm, a local brewery, has committed to join the efforts of the Heredia city water utility to compensate upstream landowners for managing their forests in accordance with Forest Stewardship Council (FSC) certification standards (IIED 2010).

Subsidies to legalize tenure of lands participating in PES schemes have been provided in the Panama Canal Watershed and Platanar in Costa Rica (IIED 2010; World Business Council for Sustainable De-

velopment 2005). This subsidy program helps expand the number of participants, mainly among communities with low income levels. In different parts of LAC, communities whose decisions can impact on hydrological services are characterized by social exclusion, inequality, violence, irregular urban development, poverty, illiteracy, and low productivity, as in the case of the watersheds of São Paulo in Brazil, where socioeconomic conditions became an important factor of success or failure for PES (Jacobi 2004).

There are just a few examples of the use of pure PES in LAC, where voluntary contractual arrangements between buyers and sellers of hydrological services have emerged. The case of La Esperanza in

Table 4. Types of PES Financing

DIRECT BENEFICIARY	VOLUNTARY	INVOLUNTARY
Utility-level	Costa Rica - Small hydropower project payments	Mexico - Water charges paid by utilities
Utility customer (end user)	Mexico - Water Utility voluntary check-off payments	Costa Rica, Ecuador, etc. - Utility Water Charges or "Water Funds"
INDIRECT BENEFICIARY	International NGO support and payments (i.e. TNC in Ecuador) USA - General Fund for Conservation Reserve Program	Costa Rica-fossil fuels tax for Payments for Environmental Services Program

Costa Rica is a transaction between two private parties, whereby the La Esperanza hydropower enterprise agrees to pay a private provider of hydrological services, Monteverde Conservation League, which manages the Children's Eternal Rain Forest that covers most the hydropower plant's upper catchments (IIED 2010; Rojas and Aylward 2002). No intermediary was needed because the negotiations were conducted directly, resulting in a 99-year contract between the two parties. Another example of voluntary action is the case of Syngenta – a Living Water project, in Parana state, Brazil (World Business Council for Sustainable Development 2008). This project consists of recovering and preserving natural springs in rural areas by restoring surrounding vegetation and building basic infrastructure to improve water quantity and quality for farming communities that use Syngenta-quality seeds. The firm covers the entire cost of the project, which has expanded to several other regions of Brazil.

In the Paso de Los Caballos river basin of Nicaragua, 125 downstream households negotiated with five upstream landowners to finance reforestation and conservation on 39 ha (Corbera et al. 2007). Under the scheme, downstream households contribute \$0.31 per

11.6 CONCLUSIONS AND RECOMMENDATIONS

month to pay \$26/ha/year to upstream landholders. In return, landowners undertake SEM practices like avoiding fires, developing organic agriculture practices, conserving soil, reforesting lands, and excluding livestock from sensitive areas. This case is interesting for the view provided into the cost of SEM. Upstream landowners providing the watershed services resulting from SEM earned, on average, \$126/ha annually from farming. When surveyed, these landowners stated that a fair price for these PES activities was \$147/ha/year. While this figure is comparable with the foregone income from farming, the actual PES offer of \$26/ha/year is well below this estimate of opportunity cost. In tension with this apparent underpayment is the participation of some landowners even at compensation levels that are well below average agricultural income.

Several PES experiences in LAC have been supported, at least initially, by international donors, as were the Water Fund of Quito and Tarija in Bolivia with funds from The Nature Conservancy; Cuencas Andinas in Colombia, Ecuador, and Peru with funds from GTZ; Lake Coatepeque and Ecoservicios in El Salvador and Silvopastoral in Colombia, Costa Rica, and Nicaragua with financial resources from the World Bank/GEF Project; and Pasolac in Nicaragua, El Salvador, and Honduras from the Swiss Agency for Development and Cooperation (IIED 2010). Most programs are intended to become self-sustaining via a variety of mechanisms. However, there is a case, Los Negros in Bolivia, which depends almost entirely on an international

donation from the U.S. Fish and Wildlife Service for biodiversity conservation, which is similar to a philanthropic source of donations for ES. Another sort of incentive mechanism is product certification, used where agricultural and agroforestry practices are promoted.

Unresolved issues raised by PES schemes have been discussed in the literature. Among them are:

- **The Effectiveness of PES** in promoting conservation efforts and the provision of ES. There is some evidence that the efficacy of this mechanism varies with the scope of a program: the more general the objectives are, the less effective the PES scheme becomes (Wunder and Alban 2008);
- **Lack of additionality:** The voluntary, self-selecting nature of ES providers implies that payments may take place in lands where conservation would have happened even in the absence of the PES scheme. As a result, scarce resources for conservation might be wasted (Sierra and Russman 2006; Wunscher et al. 2008);
- **Insufficient knowledge about ecological functions** of ecosystems may prevent design of PES schemes based on actual contribution of conservation measures to hydrological flows and water quality; instead, proxies are employed to estimate performance of ES and service providers, such as the extension of forest protected or number of hectares reforested (Quintero et al. 2009);
- **The role of long-term and indirect effects** of PES schemes has been emphasized by some, recognizing the disappointing immediate impacts from conservation payments in some cases. Indirect effects include **long-term decisions on non-forest land cover** and **strengthening of local organizations** that promote environmental quality (Asquith and Vargas 2007; Sierra and Russman 2006); and
- **Cultural perceptions on access to water as a basic human right**, for which no payment is necessary (Vargas 2004), has contributed to difficulties in implementing these compensation mechanisms, principally in the Andean region.

This chapter has summarized available information—both empirical and conceptual—on the role of hydrological services, with emphasis in the LAC region. The content has reviewed estimates of the impact and value of those hydrological services, using this approach to consider the trade-offs between two stereotypic approaches to land management decision making: “business as usual” (BAU), with no consideration of externalities, and “sustainable ecosystem management” (SEM), with integration of downstream impacts. Finally, this chapter explored the experience to date with payment of water-related environmental services in the region.

The findings point to no easy answers. Clearly, the benefits and costs related to hydrologic services are highly site- and situation-specific and will be impacted in complex ways by land management practices, whether they be BAU-oriented logging, forest conversion, and grazing, or less intensive, more broadly integrated SEM practices. Hydrological changes induced by altered land management create economic externalities when they interact with downstream production processes. The size and sign of these externalities is context specific; thus, conclusions are best framed in the context of general principles. Salient findings include the following:

1. When land-use and land management practices change, the effect on downstream water quality is the primary factor that impacts economic production. Effects on water quantity are less important and their impacts less consistent: they can be either favorable or not, depending on local circumstances of climate, soils, hydrology, infrastructure, and production processes.

Over the past decades, scientific understanding of the role of ecosystem management in hydrological function has advanced, particularly in the humid tropics. A preponderance of studies confirm (1) the importance of maintaining intact ecosystems to avoid downstream reduction of water quality, and (2) the generally negative influence of forests on overall water production (but not always on dry season base flow).

2. To improve economic decision making, impacts by upstream actions on downstream hydrological services should link to on-site incentives for SEM, but can only do so when mechanisms like payment for environmental services (PES) are in place to internalize these external factors for upstream land managers.

LAC countries have a long history of donor- and government-led investments in watershed protection and management. In the last decade, the region has contributed to the development of environmental policy by testing PES schemes that tie downstream benefits to upstream decision making. These mechanisms now come in many kinds of private and public initiatives. While these PES mechanisms still have only limited coverage in the region, the rapidity with which they are being replicated and scaled up suggests that PES schemes can be a major force for SEM, and that investment in watersheds by water users is, increasingly, a mainstream idea.

3. Risk aversion is the primary concern in intact headwater catchments, which should be maintained to protect downstream economic uses of water and physical infrastructure.

In intact, SEM-practicing headwater catchments, the risk and potential cost of altering land-use patterns and moving toward BAU in terms of degrading downstream water quality argues for maintenance

of ES and expenditure on ecosystem protection. The benefits of this expenditure come in the avoidance of potentially large, near-term avoided costs to water development infrastructure—water treatment, irrigation, and hydropower—in the form of avoided operational and maintenance expenditures, and by postponement of investment in additional infrastructure.

4. In degraded headwater catchments, infrastructure matters and caution needs to be exercised before investing in major land-use change.

In degraded headwater catchments, the choice of whether to invest in ecosystem restoration should be influenced by the following considerations:

- Restoration is a complex endeavor, requiring significant investment and sustained effort.
- Hydrological services may take time to recuperate and may be suffer from long-term degradation.
- Where water development infrastructure exists (e.g., storage, hydropower, or water treatment facility) the built facilities may be shielding water users from the negative impacts of poor ecosystem management; thus, the gains from ecosystem restoration may be limited and only emerge in the long term.
- If water development infrastructure has not been built, cost-effective ecosystem restoration may be the preferred approach to improve access by downstream users to clean water supplies.

Installed infrastructure removes society somewhat from reliance on natural ecosystem function. Where infrastructure exists, the built environment must be integrated into a broader SEM approach. Where such infrastructure is only contemplated the choice is more complicated. The durability of an ecosystem solution versus that of an infrastructure solution needs to be clearly assessed and incorporated into decision making. In many basin landscapes, there will be a role for both natural and built producers / enhancers of hydrological services.

5. SEM alone, in the narrow sense of natural ecosystem management, may not be sufficient for environmental protection and the provision of freshwater services; investment in sanitation and attention to water infrastructure may be required. (Hydrological Services Rule of Thumb #3.)

Maintenance of existing ecosystems and their hydrological services can be a cost-effective option to protect rural community water supplies; however, there remains a need to invest in human sanitation and sustainable agricultural practices to maintain downstream ecosystem health and to provide clean water for downstream communities. Downstream problems of low water quality and supply typically are a function of surface water diversion, damming of rivers,

and over-extraction of groundwater in upstream land use. These problems are often aggravated by upstream release of pollutants into waterways or groundwater. Solutions must consider both land and water management in the watershed.

6. SEM, in the broad sense, can support both sustainable water management and pro-growth policies.

SEM solutions consider all factors; at times, the economic benefits from BAU production and the costs of ecosystem restoration will be too large to justify investment in restoring ecosystems, but linkages between land allocation, and land-use and land management practices suggest that BAU may often be unsustainable over the longer term, while negatively affecting downstream communities and economic uses in the short term. In sum:

- For drinking water supply, SEM helps to improve human health, promote rural productivity, and both save operational costs and postpone capital costs for water treatment and water storage infrastructure.

- For agriculture, SEM helps to avoid system maintenance costs, freeing up producer time and resources to invest in production activities.
- For hydropower, SEM increases profit and generates more power from projects over a longer term, thereby reducing strain on the power system and postponing further infrastructure investment.

7. SEM is likely to benefit the poor, remote, and marginal segments of society disproportionately.

Water development infrastructure is less prevalent in remote, impoverished, or indigenous areas; the benefits of BAU and of water development infrastructure accrue more often to urban populations and wealthy sectors. The benefits of SEM are often realized by those without access to infrastructure or to a social safety net, while the costs of BAU are often visited on the poor, rural, and marginal groups, in the form of degradation of water quality and other externalized costs.

CHAPTER 12

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