ENVIRONMENTAL SYNOPSIS 1993

DOMINICAN REPUBLIC

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THE DOMINICAN REPUBLIC AT A GLANCE

Occupying the eastern two-thirds of Hispaniola, with Haiti to the west, the Dominican Republic is a victim of almost annual devastating hurricanes. But it is also suffering a series of environmental problems that by the start of this decade had become a crisis. The problems include:

- Deforestation — since the start of the century tree cover has declined by 85%, requiring timber imports that cost US$30 million a year
- Erosion — deforestation and slash-and-burn agriculture are causing losses of up to 3cm of topsoil a year in some areas; reservoirs, aqueducts and irrigation canals are silting up
- Declining soil productivity — in some irrigated areas over half the soils are degraded
- Coastal damage — the Republic's near-shore coral reefs and mangroves are at risk from human activities
- Poor infrastructure — remedial efforts are hampered by inadequate institutions and little environmental awareness

Among the positive developments:

- The government is taking steps to diversify its energy supplies, particularly to reduce oil imports and reliance on fuelwood
- A large number of NGOs have sprung up to help protect and manage the Republic's natural resources
- Several international agencies, including the EC, are working at governmental and grassroots levels to promote conservation activities and environmental training

CONTENTS

PREFACE

This environmental overview of the Dominican Republic was requested by the Commission of the European Communities — specifically the Directorate-General for Development (DG VIII A/1).

It was prepared on the basis of a desk-top study of information to hand as a briefing for CEC officials. Wherever possible the most recent figures and information were employed as sources[1].

After the introductory Fact Sheet and outline of Key Issues, the report is divided into three chapters. The first deals with institutional infrastructure, especially within the environmental context, together with national and international legislation and training opportunities. The second reviews the country's natural resources. The final chapter evaluates the nation's ecological heritage and considers its past, current and foreseeable environmental problems. Because the information changes so rapidly, no attempt has been made to provide a comprehensive survey of international organisations working in the Dominican Republic. Instead, the reader is advised to contact the organisations themselves for an up-to-date summary of activities.

The IUCN team responsible for the preparation of this Synopsis included: Jeremy Carew-Reid, Jacqueline Sawyer, R. David Stone, Peter Hulm, Paul A. Driver, Claire Santer, John Watkin, and Brian Johnston. Additional editorial assistance was provided by Anthony J. Curnow, Adrienne Jackson, Paul E. Ress, Gamini Senevirate and Wendy Lubetkin.

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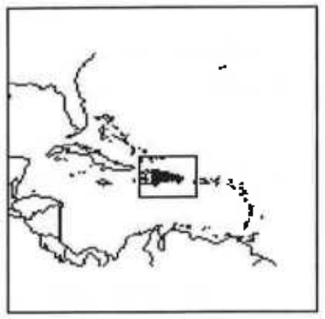
[1] A note on the data sources follows the detailed reference list. Within the text, individual sources are indicated by the number of the reference inside brackets, e.g. [24]. Metric weights and measurements are used throughout. A billion refers to 1,000,000,000.

FACT SHEET



Natural Resources

Land area: 48,482km²

Climate: Moderate tropical. Annual mean temperature 25°C, slightly less (21°C) in central mountains. Tropical storms and hurricanes are common, and most rain falls between May and November. Intense evaporation

Rainfall: Annual average rainfall 1350mm, with more in the north- east, less in the west

Ecological zones: Nine zones have been identified on the basis of climate and vegetation: subtropical thorn woodland; subtropical dry forest; subtropical moist forest; subtropical wet forest; subtropical rain forest; subtropical lower montane moist forest; subtropical lower montane wet forest; subtropical lower montane forest; and subtropical montane wet forest

Languages: Spanish

Main towns: Santo Domingo (capital) 2,200,000; Santiago 467,000; La Vega 189,000; San Francisco 162,000 (1988 population estimates)

Currency: Dominican Republic peso (RD$) = 100 centavos. Average exchange rates (1992): 12.76 pesos = US$1 and 22.14 pesos = UK£1

Measures: Metric system

Land use: Area under cultivation 18,982km²; permanent pasture 20,401km²; woodland 6521km²; (1980) [29]

Protected areas: Four categories of protected areas are recognised (national park, scientific reserve, faunal sanctuary and scenic route) encompassing some 9642km² (20% of the Republic in 1990)

Agriculture: The main food crops are rice, maize, cassava, plantains, beans, tomatoes, bananas and mangoes. The main cash crops are sugar, tobacco, coffee, cocoa and rice

Livestock: Cattle 2,250,000; pigs 435,000; sheep 120,000; goats 555,000; horses 320,000; mules 133,000; asses 143,000; poultry 28 million (1991)

Fisheries: 20,000 tonnes (1990)

Mining: Ferro-nickel 75,000 tonnes (1990); gold 5750kg (1990); silver 38 tonnes (1989); bauxite 185,000 tonnes (1989)

Demography

Population size: 7.32 million (1991)

Population growth: 2.45% per annum (1985-1990)

Projected population in 2025: 11.44 million

Age distribution: Under 15 years 37.9%; 15-65 years 58.7%; over 65 years 3.4% (1990 estimate)

Fertility rate: 3.5 (1985-1990)

Urbanisation rate: 3.9% of population a year (1990)

Health and Education

Infant mortality (deaths/1000 live births): 125 (1960); 61 (1990)

Mortality of under-5s (per 1000 live births): 199 (1960); 78 (1990)

Life expectancy: 66 years; males 63.8; females 68 (1985-1990)

Access to safe drinking water (% of population): 63.2%; urban 86%; rural 33% (1986-1987)

Access to sanitation services (% of population): 66%; urban 72%; rural 59% (1983-1985)

Access to health service (% of population): 80% (1985-1987)

Enrolment in education:

Level	Number enrolled	% male	% female
Primary (1989) Secondary (1985) University (1985)	1,032,055 463,511 123,748	51	49

Industry and Pollution

Main industries: Cement, textiles, clothing and footwear, leather goods, paper, glass, food and beverages, cigarettes, tourism

Energy: *Types:* petroleum, coal, bagasse, hydroelectric, wood. *Consumption:* hydro-electric 25%; wood/charcoal 20%

Pollution: Pesticides, industrial waste, urban sewage, salinisation

Economic Indicators

GDP: US$5.1 billion (1991)

GDP per capita: US$790 (1991)

GDP growth rate: 2.5% (1980-1989)

Agricultural % of GDP: 15.2% (1990)

Exports at current market prices: US$2326 million (1991)

Imports at current market prices: US$2441 million (1991)

Total official development assistance: US$173.1 million (1989)

Total external debt: US$4492 million — of which long-term debt amounted to US$3554 million in 1991

Sources: [2, 3, 4, 9, 14, 15, 17, 18, 19, 20, 21, 22, 23, 35, 36, 37, 38, 39, 40, 41, 42 and 43] unless otherwise indicated

KEY ISSUES

Background

The Dominican Republic lies in the Caribbean Sea between latitudes 17° and 20°N, and longitudes 68° and 72°W, sharing the island of Hispaniola with Haiti (Fig. 1). It is located about 1072km south-west of Florida and 120km west of Puerto Rico. The Republic covers the eastern two-thirds of Hispaniola and includes the islands of Beata, Catalina, Saona, Alto Velo and Catalimita. It extends over 386km from east to west and 261km from north to south. Its only international boundary — with Haiti (290km) — has been historically subject to disputes [8]. Exchange across the border with Haiti is kept to a minimum by poor road and diplomatic communications [2].

Environmental problems are not a major popular concern though the scars of abuse and degradation are widespread. Some critical issues are highlighted below.

Weak environmental legislation

Government policy on conservation and protection of natural resources is inadequate. There are no national guidelines on which to base environmental legislation. As a result the legislation is often incongruous and inefficient. The financial and administrative resources allocated to implement existing laws are inadequate [7]. A thorough review of current legislation has been recommended.

Given the scale of habitat degradation (see below and Analysis of Pollution and Degradation Processes) this issue is of particular importance for protected area management. Despite the existence of 17 protected areas, which cover about 20% of the country, the present network of reserves does not include all major ecosystems. Many are under-represented or absent altogether, especially montane forest. All protected areas suffer from interference, chiefly from charcoal dealers and farming. Little attention has been given to involving rural communities in planning and management of protected areas.

Habitat degradation

The general trend is towards degradation of natural resources. By the beginning of the 1990s, the Dominican Republic was experiencing an environmental crisis, with extensive deforestation, erosion, declining soil productivity, disturbance of rivers and streams, water pollution and degradation of coastal areas [10]. Long-term abuse of land and water resources had amplified the consequences of natural disasters such as Hurricanes David and Frederick in 1979.

Inappropriate development and lack of controls have resulted in widescale habitat degradation. One of the most serious of these problems relates to soil erosion. Soil erosion in watersheds alone is estimated at 100-150 tonnes/ha/year. Apart from the loss of soil this leads to considerable problems with sedimentation in hydro-electric reservoirs, aqueducts and irrigation projects [8]. Many dams and canals now operate at less than 50% of their planned capacity. Deforestation and clearance of natural vegetation in upland areas has also resulted in poor water retention, increased runoff, loss of soil nutrients, and flooding. Salinisation and loss of soil structure are thought to affect over 50% of the country's soils [10, 14].

Deforestation and related threats to biodiversity

An estimated 13% of the country is now under forest, a considerable reduction from the estimated 80% during the early 1900s. Much of the remaining forest occurs as fragmented and highly dispersed small patches. Lowland forest — broadleaved rain forest, evergreen and cloud forest — are especially threatened as a result of clearance for agriculture. Semi-deciduous forests are also under pressure from collection of fuelwood and charcoal production. Coastal development for tourism has resulted in the loss and destruction of many mangrove forests.

Establishment of sugar cane and coffee plantations has resulted in widescale deforestation, particularly in the west and north-east. Forest land cleared for pasture accounted for almost 80% of all forest cleared between 1972 and 1986 in the western half of the country. Little effort has been invested in promotion or establishment of reforestation programmes.

Little detailed information exists on the country's animal and plant populations apart from a few studies of pine (*Pinus occidentalis*) forests. many native species are, however, known to be threatened as a result of overhunting and habitat loss. Some information is available on land-use patterns and populations within the national parks, sanctuaries and scientific reserves. Information about land-use patterns outside these declared conservation areas is limited [7].

The American connection

The country is a beneficiary of the US Caribbean Basin Initiative (CBI), which came into effect on January 1, 1984, and was expanded with effect from October 1, 1990. The CBI provides duty-free access to the USA for a wide range of regional exports, as well as other benefits. The Dominican Republic is also a beneficiary of the San José Pact under which Venezuela and Mexico supply crude oil to certain Central American and Caribbean countries on concessionary terms. In 1989 the Dominican Republic signed a tax information exchange agreement with the USA.

The USA has long been the Dominican Republic's main aid donor, supplying nearly 90% of total bilateral aid in 1985. But 1986 brought a major decline, and neither 1987 nor 1988 saw improvement. Multilateral aid also declined steadily from 1985 to 1988. Both types of aid increased, however, in 1989. The USAID contribution to the Dominican Republic was US$55.5 million for 1989 (still 47% below the 1987 level). The Republic joined the Lomé Convention in 1989, which made it eligible to receive ECU 85 million (US$120 million) in development aid in the period to 1994 [2].

A future dependant on conservation

Attempts to solve environmental problems are hindered by the complex and inefficient nature of government institutions, the continuing unrestricted development of lands for tourism and agriculture, and an overall lack of consciousness among the Dominican people concerning the importance of natural resources [7]. Because the Dominican Republic has no National Conservation Policy, there is little coordination between public institutions dealing with natural resources, and conflicts often arise [4, 7].

Despite the expansion of agriculture through major irrigation projects, the country is a net importer of food. Even though the government is aggressively developing the substantial hydro-electric potential, 85% of national power needs are met by imported petroleum. The Cordillera Central watersheds, which are absolutely fundamental to irrigated cropland and hydro-electric projects, have been severely degraded by slash-and-burn agriculture. With steadily increasing population pressures on the land and no traditional agricultural frontiers left, hillside farmers have nowhere to go. Watershed protection and rehabilitation will remain a major challenge.

INSTITUTIONAL CONTEXT

Environmental Institutions

Twelve governmental institutions have responsibility for natural resource administration and management. The main ones are:

- the National Park Directorate (Dirección Nacional des Parques, DNP), which administers, develops and cares for protected areas;
- the National Forest Directorate (Dirección General de Foresta, DGF), which is responsible for conserving and developing forest resources, as well as ensuring their use in a sustainable manner;
- the National Technical Forestry Commission (Comisíon Nacional Forestal, CONATEF), which regulates the activities of DGF;
- the Wildlife Service (Departamento de Vida Silvestre, DVS), whose function is to inventory and manage national flora and fauna for conservation purposes; and
- the Fisheries Service (Departamento de Recursos Pesqueros, DRP) [4, 7].

Many of the assigned powers and responsibilities for these bodies overlap those of other government agencies. They are also hampered by lack of funds and staffing systems often influenced more by political patronage than technical or managerial qualifications. The government allocations for these agencies total less than 1% of the national budget and 70% is spent on personnel, leaving little for field programmes. Employees in government agencies responsible for enforcing the laws face many disincentives: they are inadequately trained, their salaries are low, and they receive little logistical support [7].

Other environmental institutions include:

- the Department of Inventory and Regulation of Natural Resources (Departamento de Inventario y Ordenamiento de Recursos Naturales);
- the Land and Water Department (Departamento de Tierras y Aguas);
- the Environmental Education Department (Departamento de Educación Ambiental);
- the Marine Biological Centre (Centro de Biología Marina);
- Dr Rafael Moscoso's Botanical Garden (Jardín Botánico Nacional "Dr Rafael Moscoso";

- the Natural History Museum (Museo Nacional De Historia Natural); and
- the National Zoological Park (Parque Zoológico Nacional) [5].

Environmental Policies and Standards

From the 'discovery' of Hispaniola in 1492 until the end of the 19th century, the government took little action to regulate the use of biological resources or to conserve them. There is still no comprehensive government policy to protect and conserve the country's biological resources. Without constitutional provision for natural resource protection, there are no national guidelines on which to base environmental legislation. As a result, this legislation has often been incongruous and inconsistent, reducing its effectiveness. Other governmental sectors can formulate and pass laws which may directly contradict conservation laws, such as urban development or mineral exploitation in protected areas [4, 7].

National and International Organisations

Technical and financial assistance is provided by several international organisations, including the CEC, USAID and the Inter-American Development Bank (IADB). Details of their work are given elsewhere in the Synopsis.

Three American NGOs (TNC — The Nature Conservancy, WWF-US — World Wildlife Fund, and CMC — the Center for Marine Conservation) and Cornell University are deeply involved with the Samaná 'Biosphere Reserve' project (see below). Most NGOs are unified by the Dominican Federation of Ecological Associations (Federación Dominicana de Asociaciones Ecológicas, FEDOMASEC), which coordinates the activities of conservation organisations and formulates guidelines for the environmental protection and education projects of its members [4].

Many NGOs in the Dominican Republic work on conservation and environmental protection. Among the largest and most active groups is the Nature Foundation (Fundación Fondo para la Naturaleza, PRONATURA) which promotes scientific research of natural resources to further conservation and environmental development. The Centre for Conservation and Ecodevelopment of the Samaná Bay and Surroundings — CEBSE (El Centro para Conservation y Ecodesarrollo de la Bahina de Samaná y su Entorno, Inc) is another major conservation NGO.

NGOs have been acknowledged to a limited degree by the government environmental sector since the late 1980s. Since then, a large number of NGOs have been established whose work has contributed substantially to the protection and management of natural resources [4].

Legislation Concerning Natural Resource Management and Environmental Protection

The Dominican Republic ratified the (World Heritage) Convention Concerning the Protection of the World Cultural and Natural Heritage on 12 February 1985, but no sites have been inscribed to date. It is not a party to the (Ramsar) Convention of Wetlands of International Importance especially as Waterfowl Habitat, nor does it participate in the UNESCO Man and the Biosphere (MAB) Programme, but plans are under way to do so [4]. The Dominican Republic has not signed the (Cartagena) Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, its related Protocol Concerning Cooperation in Combating Oil Spills or its Protocol Concerning Specially Protected Areas and Wildlife.

The Dominican Republic signed the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere in 1940, and it has since been ratified. In 1982, the Republic joined the Caribbean Conservation Association (CCA), a regional, non-governmental, non-profit organisation dedicated to promoting policies and practices which contribute to conservation, protection and wise use of natural and cultural resources. It is also a party to the (CITES) Convention on International Trade in Endangered Species of Wild Fauna and Flora [7].

The Dominican Government issued its first decree to conserve natural resources in 1884. Since then, more than 126 laws, decrees, resolutions and regulations have been promulgated to protect and regulate the use of the country's natural resources. Proposals from USAID to add a clause relating to nature conservation to the 1966 Constitution were put forward in 1974 but not acted on. A thorough revision of current legislation is required to remove inconsistencies, such as the 1931 Hunting Law which contrasts with later legislation providing for wildlife protection [4, 7].

Environmental Training Institutes and Training Capacity

The Technology Institute of the Eastern Cibao, the Santiago University of Technology, the Central University of the East and the Catholic University (PUCMM) offer courses in forestry, natural resources and/or fisheries management and conservation [7].

WWF-US and the National Zoo have been involved in training 2700 teachers from the north-eastern zone in environmental education. The government has drawn up several programmes to incorporate nature conservation and awareness topics into school curricula, but has failed to implement them [7].

Cultural Aspects of Resource Utilisation

Certain social and cultural biases hinder conservation efforts. For example, people of the educated and influential upper class have tended to visit the country only when travelling to

their farms, and have demonstrated little interest in nature. On the other hand, the people who live in rural areas and depend most on biological resources are generally poor and have little political influence [7]. More recently, however, environmental problems have become topics of greater popular interest and concern [10]. As a result a conservation consciousness has been created among the wealthier, predominantly urban residents by awareness campaigns. The brochures, bulletins and other public relation efforts have had little effect on the rural populations, however, such as those who depend on hunting for their livelihoods [7].

STATE OF THE ENVIRONMENT

Inventory of Natural Resources

Ecological zones

The Dominican Republic rises from sea-level to over 3000m in altitude, producing a range of temperatures and ecosystems.

The country divides naturally into highlands and lowlands. The highlands are four parallel mountain ranges, the Sierra de Bahoruco, the Sierra de Neiba, the Cordillera Central (the highest range and principal watershed) and the Cordillera Septentrional consisting of long parallel valleys between the ranges, all lying in a predominantly north-westerly direction. There are also numerous small valleys and basins and extensive marshlands in the bay areas [8].

The Republic lies in a tropical maritime zone, but the heat is moderated by ocean currents and year-round trade winds. Seasonal variations in temperature are relatively small; they rarely fall below 15.6°C or rise above 32.2°C. Rainfall is heaviest in the north and east. The entire coast is subject to severe hurricanes during the rainy season, from May to December. The country has been hit by such storms almost every year since the Spanish began keeping records in the late 15th century. Mean annual rainfall ranges between 700mm on the plains and 2000mm on the mountains, with an average rainfall of 1350mm. Because of its location and topography, the country is very susceptible to flash floods. Major flooding often occurs, causing damage and loss of life [8].

Following the Holdridge classification system [27], nine ecological life zones can be identified [24], as summarised in Table 1 (see also Forest).

The country has a high degree of biodiversity and endemism. Around 36% of the floral species found on the island of Hispaniola are endemic [4]. The Dominican Republic itself has more than 5000 vascular plant species [12].

Water

The Dominican Republic is richly endowed with water resources, particularly those river systems originating in the Cordillera Central (Fig. 2). The country's longest river is the Yaque del Norte. Together with the Yuna River, it drains the Cibao Valley. Over 35% of the country is included in the river basins of the Yaque del Norte, Yuna and Yaque del Sur Rivers.

The San Juan Valley is drained by the Artibonto River and its tributaries, and the Yaque del Sur and its tributary, the San Juan. The Caribbean coastal plain is drained by the Ozama and the Macoris rivers. All of these rivers are shallow and subject to seasonal changes [8].

Table 1. Areas of Holdridge Life Zones in the Dominican Republic

Life Zone	Unit Area (km^2)	Total Area (km^2)
1. Subtropical Thorn Woodland		1,001
2. Subtropical Dry Forest		9,662
a. Non-transitional	9,812	
b. Warm-moist transition	150	
3. Subtropical Moist Forest		22,794
a. Non-transitional	22,139	
b. Warm-dry transitional	500	
c. Warm-moist transitional	155	
4. Subtropical Wet Forest		6,834
a. Non-transitional	6,808	
b. Warm-moist transitional	26	
5. Subtropical Rain Forest		56
6. Subtropical Lower Montane Moist Forest		3,480
a. Non-transitional	3,214	
b. Cool-dry transitional	23	
c. Cool-moist transitional	243	
7. Subtropical Lower Montane Wet Forest		3,577
a. Non-transitional	3,557	
b. Cool-moist transitional	20	
8. Subtropical Lower Montane Rain Forest		36
9. Subtropical Montane Wet Forest		303

The Republic has about 1500km of coast (including the islands), characterised by a combination of coralline reefs and escarpments, river estuaries, beaches and marshlands. About 166km of the coast is bordered by reefs and 268km by mangrove [6].

Information on wetlands is very limited. In 1980 Bonnelly de Calventi and Garcia de Geralde drew up an inventory of the nation's water bodies on the basis of existing maps. According to these authors, the Dominican Republic possessed 270 lakes, lagoons and ponds varying in size from 0.01 to 25.75km^2. It is thought, however, that many have since disappeared [5].

The largest expanse of mangroves is found in Bahía de Samaná and has *Rhizophora mangle, Avicennia* and *Conocarpus* spp. [6].

Forest

The vegetation pattern is most easily interpreted using Holdridges Life Zone System (see Table 1 and Fig. 3).

Covering almost half the country, the natural vegetation of the Subtropical Moist Forest Life Zone is characterised by well-developed heterogenous forest of broadleaved trees. *Catalpa*

longisiliqua and mahogany are characteristic tree species. The royal palm (*Roystonea regia*) is very common on limestone-derived soils. Other occasional trees include *Bucida buceras, Chlorophora tinctoria, Citharexylum fruticosum, Genipa americana, Oxandra lanceolata, Simarouba glauca* and *Tetragastris balsamifera.*

The second most extensive Life Zone in the country covers most of the western Cibao (lower Yaque del Norte Valley), San Juan and Neiba Valleys, as well as much of the Azua and Bani plains as far as Hato Viejo south of San Cristobal. The vegetation is classified as being subtropical dry forest, consisting of a low, single stratum forest with an abundance of sclerophyll-leaved trees. The most abundant tree species are *Prosopsis juliflora* and *Acacia farnesiana.* Other species include *Guaiacum officinale, G. sanctum, Bursera simaruba, Phyllostylon brasiliense* and *Plumeria alba.* These dry forests are the major source of firewood and charcoal as well as the primary areas for browsing goats [29].

The Cordilleras Septentrional and Oriental have the most extensive area of subtropical wet forest, which is a multi-layered assemblage of broadleaved trees. Characteristic species include *Alchornea latifolia, Buchenavia capitata, Bytsonima spicata, Casearia arborea, Hymenaea courbaril* and *Manilkara bidentata.* Subtropical rainforest occurs in isolated patches around Casabito Hill and two isolated areas in the Cordilleras Septentrional and Oriental. The natural vegetation of this ecozone is broadleaved forest festooned with epiphytes. Tree ferns are especially abundant. A characteristic broadleaved tree is *Linociera domingensis.*

The Subtropical Lower Montane Wet Forest Life Zone covers much of the mid-elevations (850-2100m) of the Cordillera Central, Sierra de Neiba and Sierra de Baoruco. The vegetation cover is a mixture of broadleaved and pine forests, the former dominated by species such as *Brunellia comocladifolia, Didymopanax tremulum, Diospyros ebenaster, Garrya fadyenii, Oreopanax capitalum* and *Weinmannia pinnata.* Also on the Cordillera Central, three isolated patches of lower montane rain forest exist, with annual rainfall exceeding 4000mm. The natural vegetation of this zone is typified by an abundance of broadleaved species, tree ferns and epiphytes.

The Subtropical Lower Montane Moist Forest Life Zone occurs primarily on the eastern and southern flanks of the Cordillera Central, usually above 800m. The natural vegetation is primarily open pine forest dominated by *Pinus occidentalis, Juniperus gracilor* and *Podocarpus buchii.* Broadleaved species include *Guazuam tomentosa, Garrya fadyenii, Rapanea ferruginea* and *Vaccinium cubense.* Most land in this zone has already been deforested or degraded by slash-and-burn cultivation [29].

The Subtropical Thorn Woodland Life Zone occurs in the driest areas, particularly in the south-west where the natural vegetation is dominated by spiny shrubs and cacti. The latter include *Opuntia caribaea* and *Neoabbottia paniculata.*

Of limited occurrence (36km^2) the Subtropical Lower Montane Rain Forest Life Zone is only found in three isolated patches in the Cordillera Central. The natural vegetation of this Life

Zone is characterised by the dominance of broadleaved species and the abundance of tree ferns and epiphytes.

The final Life Zone, as described in Table 1, is the Subtropical Montane Wet Forest. This occurs above 2100m and encompasses the highest peaks. Natural vegetation is predominantly open pine, although some broadleaved species such as *Buddleia domingensis, Lyonia* spp., *Verbena domongensis* and *Weinmannia pinnata* also occur.

The 1980 CRIES (Comprehensive Resource Inventory and Evaluation System) inventory of land cover indicated that only 14% (about 7000km^2) of the country is under forest, primarily broadleaved forests in the arid south-west and north-west (Fig. 3). Some forests also remain in La Altagracia province and in Los Haitises. In this study, however, most of the pine forests were classified as rangeland because of the low stand density [25]. Therefore, this figure of 14% forest cover is believed to be an underestimate.

The status of the various forest types varies considerably. For example, the extensive pine forests in the Bermudez and del Carmen Ramirez National Parks appear in excellent condition through the protective efforts of the National Parks and Forests Directorates (DNP and DGF, respectively). The introduction in 1967 of a law closing sawmills and prohibiting the cutting of trees was a major factor in reducing further destruction of this forest type.

The lowland broadleaved forests, however, have not received adequate protection and are now consequently facing intense pressure from slash and burn agriculturalists as well as charcoal makers. Although differing criteria and classification techniques make it difficult to compare forest area statistics, observations and interviews indicate that considerable deforestation is continuing, largely unabated in the broadleaved forests. Active protection by DGF and DNP of the two Cordillera Central national parks seems to have slowed the agricultural advance in the upper valleys. Slash-and-burn agriculturalists are active, however, in the western dry forests as well as the humid forests of Los Haitises and La Altagracia.

A number of potentially economically important forest tree species exist. They include the small-leaf mahogany (*Swietenia mahogani*), Caribbean oak (*Catalpa longissima*), cedar (*Cedrela odorata*), Dominican pine (*Pinus occidentalis*), Corazon de paloma (*Colubrina arborescens*), savin juniper (*Juniperus gracilior*), green ebony (*Magnolia pallescens*), ebony (*Diospyrus revoluta*), cabirma (*Guarea guidonia*), mera (*Calophyllum calaba*) and the mangroves (*Rhizophora mangle* and *Conocarpus erectus*) [7].

Agriculture

Agriculture remains an important economic activity for employment and exports. The sector is highly vulnerable, however, suffering from outbreaks of disease and pests, weather hazards, and declines in world prices for sugar, coffee, cocoa and tobacco (which account for approximately 90% of total agricultural exports) [1, 8]. Including livestock, forestry and fishing, agriculture accounted for 15.2% of GDP in 1990, down from 17% in 1988.

Soils with agricultural potential cover an estimated 20% of the country. Land-use figures are given in Table 2. The lack of clear land-ownership rights does not allow permanent agriculture, however, and fewer than 6500km^2 are under intensive agriculture.

Table 2. Classes of actual land use or cover in the Dominican Republic; data from CRIES (1980). [Simplified from 29]

Actual land use or cover	km^2	(%)
Urban and built-up	292	0.6
Sugar cane	4,205	8.8
Intensive agriculture	6,496	13.6
Marginal agriculture	8,281	17.4
Pasture	2,325	4.9
Rangeland	5,278	11.1
Limited rangeland	12,788	26.8
Broadleaved forest	6,518	13.7
Pine forest	311	0.7
Wetlands (including rice)	269	0.6
Barren or Open	402	0.8
Inland water	315	0.7
(Cloud cover obscuring details)	177	0.4
Total	47,657	100.0

The majority of farms (70%) are less than 5ha in size, which is not sufficient for most families [28, 29]. As a result, peasant farmers move frequently, particularly to less-populated mountainous regions. Their inexperience of cultivating such difficult landscapes has caused severe soil erosion in many areas [28].

The World Bank has calculated that current agricultural production is less than two-thirds of its potential [13]. Poor performance in the 1980s was partly due to unfavourable international market conditions. It also stemmed from the cumulative effects of inadequate domestic policies, which began to stifle agricultural production and exports towards the end of the 1970s. Attempts are being made, however, to eliminate or mitigate these policy constraints, for example by liberalising domestic marketing, reducing price controls, and enforcing remaining controls over milk and sugar [13].

Agricultural production takes place in six main areas, all of which are liberally fed with streams and rivers from the three high mountain ranges which cross the island. These six areas are the valley of Cibao in the north; the central areas; the region of Constanza and Tiero; the eastern region; the valley of San Juan; and the southern section [2].

The Cibao Valley is the largest and most productive region [2]. As a result, around 20% of the population lives in this area [4]. The second most important agricultural area is the valley of San Juan, whose agricultural potential will increase five times and cultivable land will expand by 490km^2, when a number of internationally financed irrigation and hydro-electric schemes come on stream [2] (see Soil Erosion and Degradation).

Production of subsistence crops, some cocoa, coffee and bananas, and the raising of pigs and cattle have given way to the exclusive cultivation of sugar cane in many communities [8].

Sugar remains the principal farm product and main agricultural export commodity, although its importance is declining. The main sugar producing region lies in the east. The total sugar area harvested in 1989 was 1700km^2 [2]. Sugar exports were valued in 1989 at US$191 million, little more than a third of the 1981 figure of US$532 million [3]. Nevertheless, sugar cane is replacing cattle pastures in a few areas [14].

In 1989 the area dedicated to coffee production amounted to 1530km^2. The crop is grown mainly on small plots in a semi-wild state in mountainous terrain. Coffee is an important source of employment, with some 250,000 workers, but both output and export earnings have fluctuated widely in recent years, with dollar receipts declining from US$112.8 million in 1986 to US$63.8 million in 1989.

Cocoa plantations cover about 1190km^2 and provide the fifth most valuable export. Like coffee and sugar, however, its value has undergone a dramatic decline, from US$66.3 million in 1987 to US$43.0 million in 1989. The Dominican Republic is the biggest supplier of tobacco to the USA.

Citrus fruit production is seen as one of the likely growth areas for Dominican agriculture. The industry, which sells largely within the Caribbean, has lately been aiming for the North American and European markets. The area under cultivation increased from 27.8km^2 in 1985 to 81.4km^2 in 1989. The country exported US$2 million worth of pineapples to the US market in 1988 and will probably increase this figure in coming years when new strains are introduced [2].

The annual harvest of paddy rice declined from 507,000 tonnes in 1984 to an estimated 462,000 tonnes in 1988 [3]. More intensive land use and shorter fallow periods have led to high rates of erosion and lower agricultural productivity. The fact that most small farmers do not own their own land has further aggravated this situation.

The Instituto Agrario Dominicano's (IAD) agricultural resettlement programme has had little impact on reducing migratory slash-and-burn agriculture in the mountains, but has led to the clearing of lowland dry forest for agriculture. Most IAD settlements have failed for lack of technical support, credit and marketing. Land titles have often been distributed to political favourites. Many recipients of plots subsequently sell or abandon them, and move back to the cities [7].

The government has various projects to assist the agricultural sector, for which it is currently seeking or has obtained external funding. Credit projects (US$178 million) would provide credit and technical assistance to an estimated 100,000 producers and focus on the production of non-traditional export crops and selected basis food crops [13]. Pineapples, African palm, other fruit, vegetables and flowers are among the new crops being cultivated [2]. Irrigation investments rank second (US$104 million) and would concentrate on the rehabilitation of the irrigation infrastructure. Investments for crop and livestock production would total about US$92 million. These would be devoted largely to export crops, including yield and quality increasing investments in, for example, coffee and cocoa and projects to expand the production of non-traditional ones [13].

Livestock

In 1991, there were an estimated 2.25 million head of cattle, 435,000 pigs, 550,000 goats and 28 million chickens in the Dominican Republic. Stocks of chickens and pigs have grown fastest in recent years (swine fever had reduced pig numbers in 1978 and 1979) [2].

Fisheries

The fishing industry in the Dominican Republic is at a low level of development. Approximately 7800 fishermen sail from the 72 commercial fishing ports [7]. Fishing is principally artisanal. Only 17% of the national catch originates from the high sea [10]. Only about 8% of the fish harvest is exported [30].

In 1981 studies suggested that the potential sea catch was 30,000 tonnes/year (this estimate does not include migratory species such as tuna, which are a commercially important species). At present, the actual catch is thought to be around 20,000 tonnes/year [3, 42].

The reefs play a major role in supporting the artisanal fisheries as well as an increasingly important role in the development of the tourist industry. Los Bajos, in Bahía Ocoa, is a particularly important site for fisheries. This deep reef (21-30m), with its large colonies of *Acropora cervicornis* corals, supports abundant fish, lobster (*Panuliris argus*) and crab [6].

Fishing of internal waters has increased in recent years, partly due to the construction of drains and dams. Exotic species such as tilapia, bass and carp are frequently caught. Introduced species such as the Louisiana shrimp (*Macrobrachium rosembergi*) have caused problems because they compete with native freshwater species [10].

Aquaculture has only recently started to develop: in 1988 the Dominican Republic had 91 subsistence fish farmers, who produced more than three tonnes of *Tilapia* in rudimentary 400m^2 ponds. In the same year, there were also 37 semi-commercial fish farmers producing 55 tonnes of freshwater shrimp, *Macrobrachium* spp., on farms of 0.1 to 0.8ha [30]. Another group of industrial entrepreneurs produced 285 tonnes of sea shrimp (78%) and freshwater shrimp (22%), clearly demonstrating the possibilities.

Protected areas and wildlife

The first national park was established in 1951. By 1983 there were still only five protected areas. But nine additional protected areas were established that year as a result of a nationwide survey and inventory of biological diversity, following the creation of the Wildlife Service (DVS) [28].

The Dominican Republic now has 17 protected natural areas (Table 3) that include national parks, scientific reserves, a faunal sanctuary and a scenic route (Fig. 4). In addition to these areas, tracts of government land still covered by forest are nominally under the protection of the National Forest Directorate. All parks, however, have suffered various forms of exploitation by illegal charcoal dealers, migratory farmers and government agencies [7].

Under Law No 67 of November 1974, protected areas are considered collectively to form a national system with three main types of conservation units: recreational area (*área recreativa*); historical area (*área histórica*), and natural and indigenous area (*área natural y indígena*). Eleven management categories are actually in use, but only eight of these are described in the 1974 Law, and then not in detail. The three other categories, forest reserve, wildlife refuge and faunal sanctuary, have been introduced but are not enforced. The lack of clear definition and conservation objectives of each designation results in contradictions and inconsistencies among them. Moreover, the present protected area system does not cover all the major ecosystems in the country. Many are under-represented or absent altogether, particularly montane forest [4].

Table 3. Protected areas in the Dominican Republic

Category	Number	Area (ha)
National Park	10	488,069
Scientific Reserve	5	60,290
Faunal Sanctuary	1	374,800
Scenic Route	1	41,000
Total	17	964,159

In several cases the government has delineated national park boundaries to include entire communities and/or areas traditionally used by local residents for farming, hunting, fishing or charcoal making. Little effort has been made to incorporate these people into park management plans, or educate them about why the area was protected and how they fit into its overall management [7].

The notable exceptions have been the Wildlife Service (DVS) and SEA (Secretaria de Estado de Agricultura) in their enforcement of the CITES Convention and their efforts, through the Park Ranger Corps, to control hunting within national park boundaries [7]. Various attempts are being made, mostly by NGOs, to study and conserve some of the native flora and fauna.

Non-renewable resources

Minerals accounted for 7% of the value of exports in 1970, 39% in 1980 and 40% in 1990 [10]. In 1989 the sector earned US$460.8 million [2]. Production of some deposits, however, is declining. For instance, gold production from state-owned Rosario Dominincana's Pueblo Viejo mine on the north side of the island, was only 138,638 troy ounces in 1990, compared with 168,417 troy ounces in 1989 [1].

The Dominican Republic ranks seventh in the world for nickel production, and second in the Americas behind Canada. Proven and probable reserves at the end of 1989 were 37.8 million tonnes of lateritic ore grading 1.72% nickel [2]. Falconbridge Dominicana is the country's sole nickel producer [26].

The main bauxite deposit is Alcoa's former facility in the Barahona province. Mining is conducted under government contract by Ideal Dominicana [2]. Production was 167,800 tonnes in 1988 [3].

Salt, gypsum, mercury and limestone are also mined. There was a significant increase in exploration activity during 1987 and 1988, when new areas were opened up, attracting mineral companies from the USA, Canada, Japan, Western Europe and Australia. Titanium deposits have been located and Falconbridge Dominicana has reported finds of copper, zinc, gold and silver at Cerro de Maimón [2]. Deposits of lignite in the Sánchez-Samaná peninsula constitute the country's main fossil fuel resource. There are plans to exploit the resource for thermal power generation [2]. Petroleum has been discovered at Charco Largo, in the south-western Barahona region, although little progress has been made in exploiting the deposit.

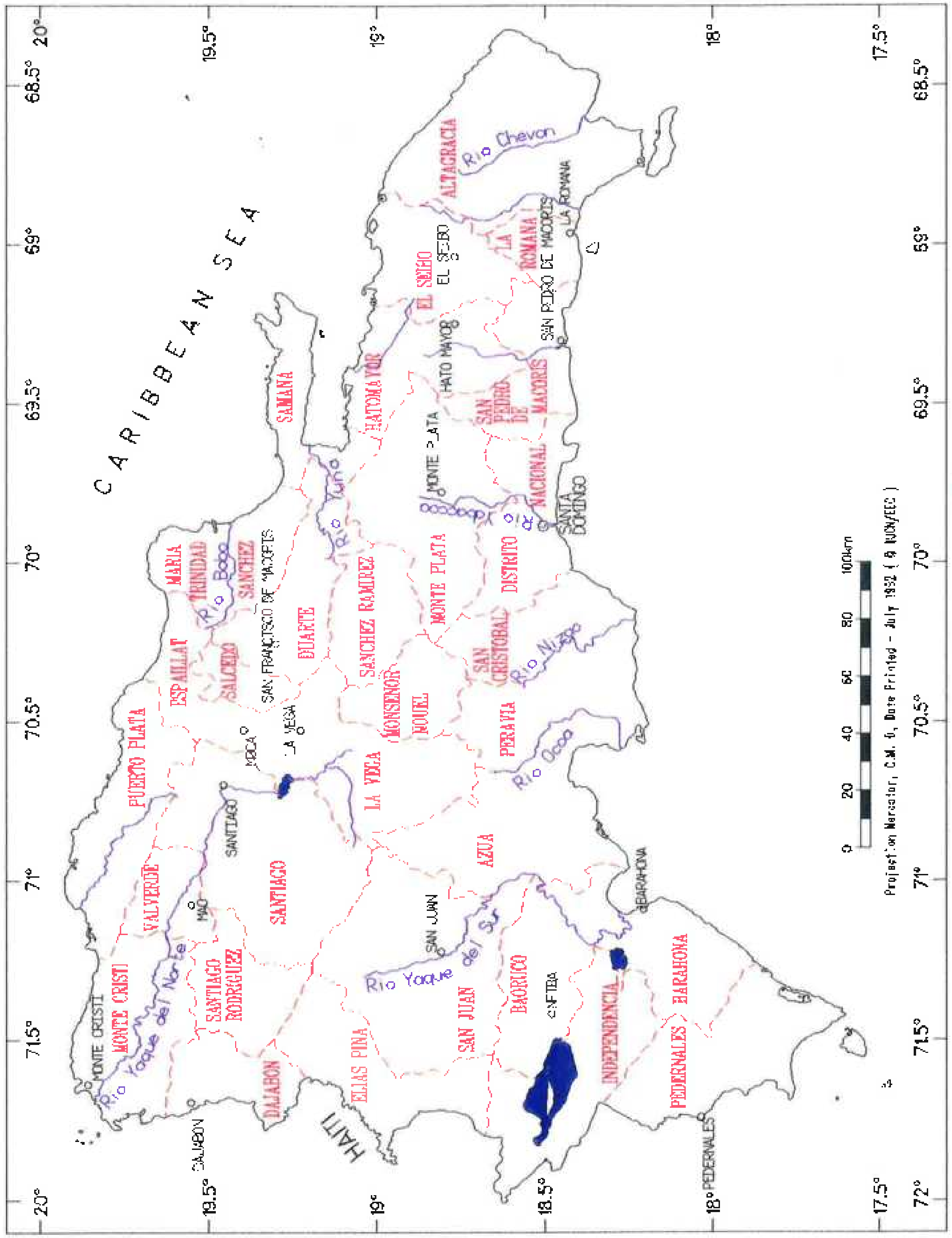


Figure 1. Administrative Boundaries —, Rivers — and major towns of Dominican Republic.

Industry

Main industrial sectors

During the 1980s, substantial investment in manufacturing and tourism took place, bringing these sectors into prominence as leading contributors to GDP and as earners of foreign exchange [3].

Manufacturing is the largest sector in share of GDP (15.6% in 1989). Almost half the sector is sugar refining. Food, beverage and tobacco industries account for 52% of value-added. Non-metallic minerals contribute 31% and textiles, clothing, leather and footwear for an additional 9%. Over time, the share of food processing has been falling, while that of non-metallic minerals, mainly construction materials, has been rising. Apart from free-zone production, manufacturing mainly serves the domestic market. It is heavily protected by tariff barriers and by Law 229, which requires that the public sector and private institutions in receipt of public funds buy local products [2].

Around 75% of the manufacturing industries produce non-durable consumer goods and depend on imported primary materials, capital goods and technology. There is little incentive for producing the durable goods demanded by the general population. For this reason the import of manufactured goods accounts for more than 60% of total imports [10]. Little stimulus is given to the development of local intermediate goods, and industries have tended to be capital-rather than labour-intensive [2].

Industrial free zones (IFZs) for exports have been very successful. The Republic now has 27 free-trade zones, housing 373 companies and providing 142,300 jobs, making it the world's largest free-zone domicile [26]. Exports from the zones increased from US$205 million in 1985 to US$771 million in 1990. The USA takes 92% of IFZ exports. According to a 1989 survey, IFZs are primarily involved in textile assembly (62% of all factories) and footwear (11%) [2]. IFZ plants also produce leather goods and electrical and electronic goods such as printed circuit boards, computer terminals and alarm systems.

Since the passage of a Tourist Development Law in 1971, the tourist industry has grown to become the republic's primary earner of foreign exchange [2, 33]. In 1990 tourism brought in US$899.5 million, or 40.5% of foreign currency earnings, an increase from US$818.4 million in 1989 and US$571.2 million in 1987 [1]. The country's precarious infrastructure, however, is a threat to the development of the industry [2].

The construction sector is fed principally by massive government capital spending on programmes such as dams, irrigation, housing and roads. Increases in private investment in hotels, offices, factories, apartments and houses also helped its growth between 1988 and 1990 [2].

Mining currently contributes about 4% of GDP, the most profitable minerals being ferro-nickel and the gold-silver alloy, doré, which in 1989 recorded export earnings of US$353 million and US$69.3 million respectively [3]. Foreign exchange earnings and government revenue will be reduced, however, by Falconbridge Dominicana's decision to

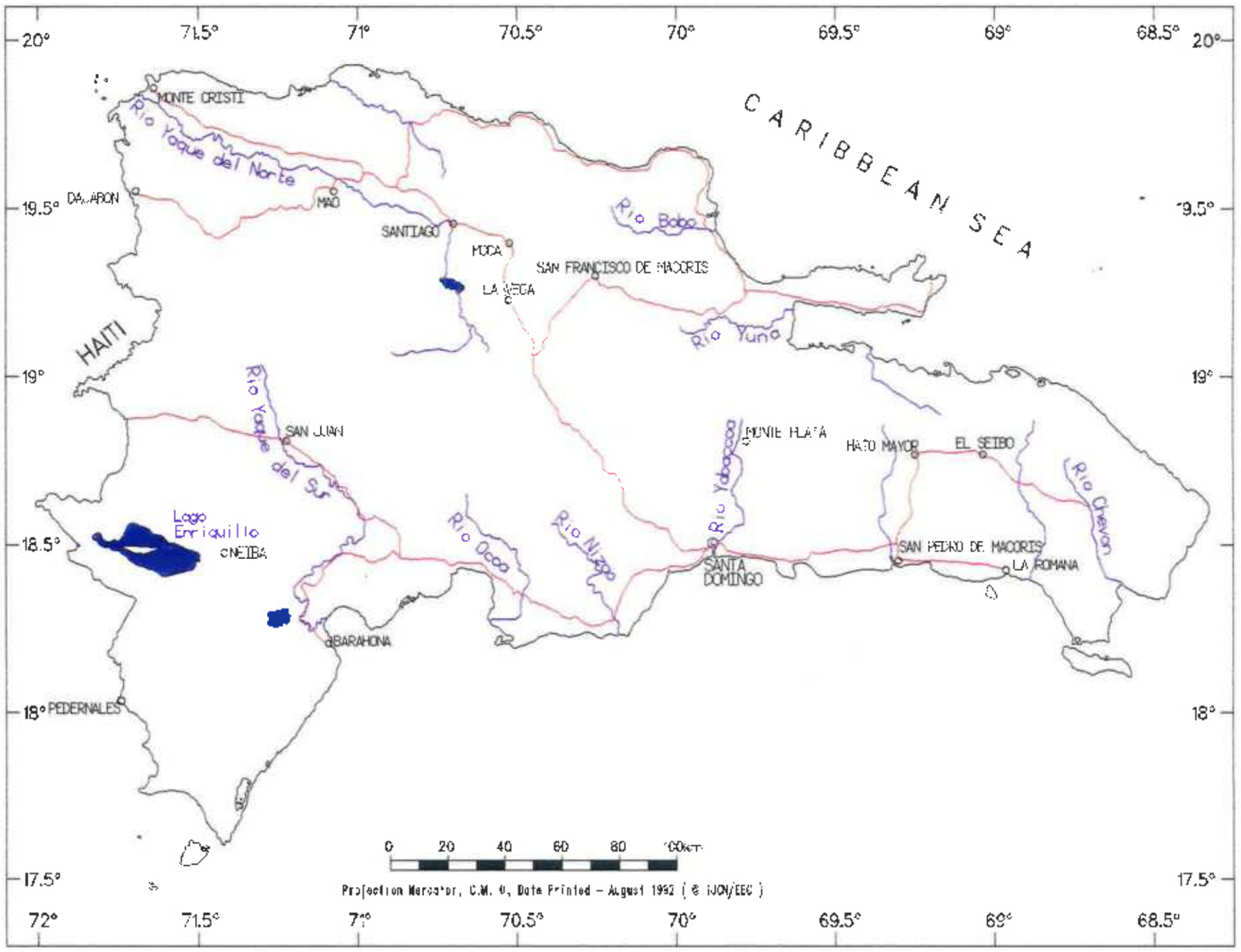


Figure 2. Major communication routes in Dominican Republic:
Roads , and Rivers .

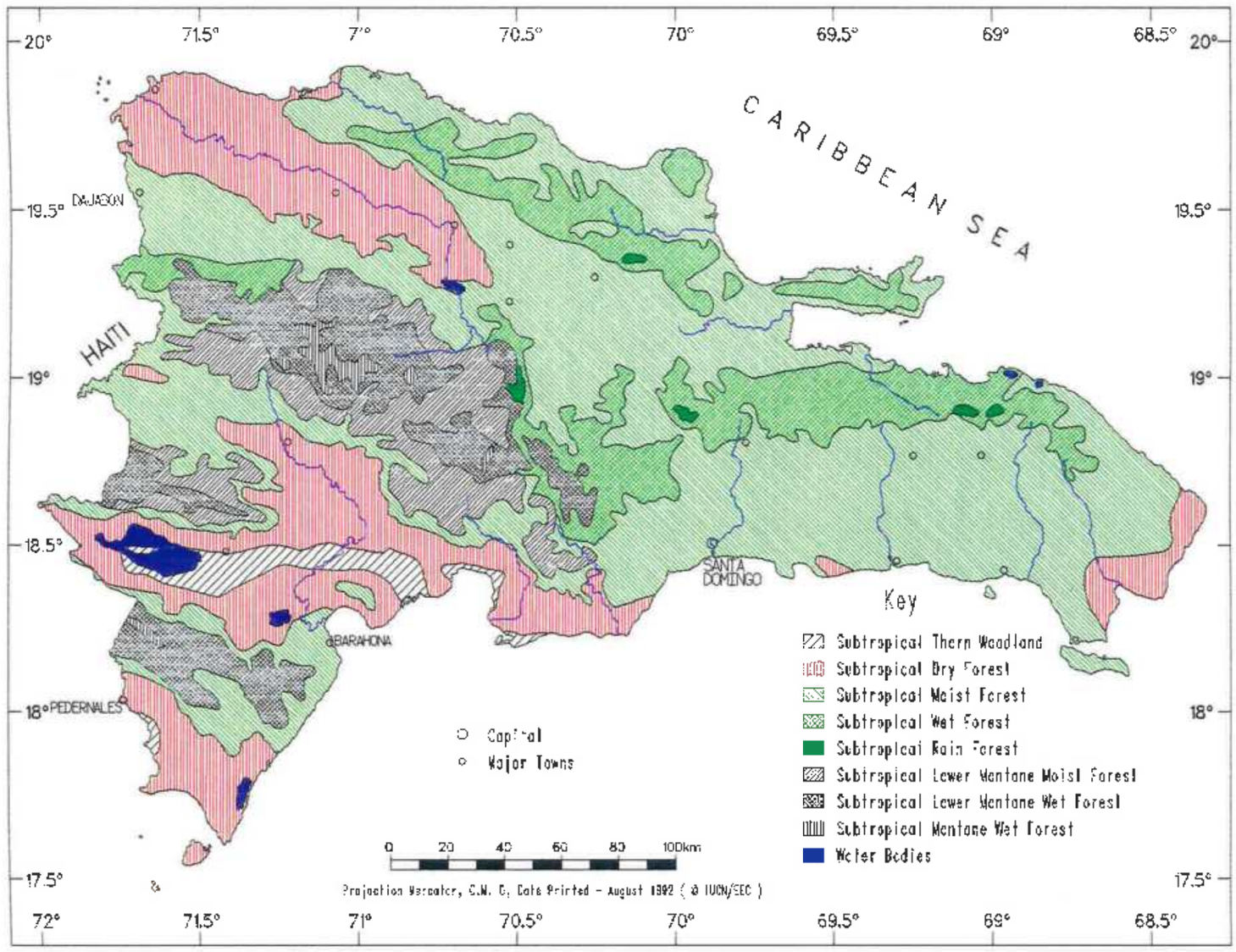


Figure 3. Vegetation Pattern of Dominican Republic:
See text and Annex I for further details.

halve its nickel production as from October 1991, as a result of a fall in the world nickel price [1]. Perhaps the most significant factor hampering development of the nation's industrial potential is its lack of fuels and inadequate energy production and supply.

Location of industry

Two new free trade zones have been established near Santo Domingo, one at San Cristóbal and one at Puerto Isabela [26]. An oil refinery at Nigua outside Haina now processes 32,500 barrels a day and there is a 16,000 barrels a day refinery at La Peguera.

Mineral extraction takes place mainly in the centre of the country, near Bonao, and in the south-west. Ferro-nickel, for example, is mined by Falconbridge Dominicana at Bonao [3].

Tourism is now a major industry on the south coast, particularly at Isla Catalina and Bahía de Andrés [6]. There are significant tourist facilities at Santo Domingo, Costa Caribe, La Romana, Puerto Cana, Puerto Plata and Playa Dorada [2].

Energy sources and consumption

The structure of the energy sector has changed little over the last five years. Production is based mainly on oil, imported on a preferential basis from Venezuela [2]. The country does not produce any petrol, gas, or coal of its own [10].

Throughout most of the 1980s consumption of petroleum products and electricity was subsidised. In 1988 subsidies on electricity and petroleum products amounted to an estimated 4.5% of GDP [13]. In 1990 oil imports totalled 22.5 million barrels, costing US$508.6 million, compared with US$405 million for oil imports in 1989. The increase resulted from price rises associated with the early stages of the Gulf crisis; within the country, the price increases and petrol rationing introduced in late 1990 brought a 20% fall in consumption [2].

Most power needs are supplied by thermo-electric plants, though hydro-electric plants are increasing in number. In 1988 hydro-electric capacity accounted for 25% of the electric production [3]. The State-owned Dominican Electricity Corporation (CDE - Corporación Dominicana de Electricidad) handles most of the production, distribution and marketing of electricity, except to the sugar mills and the Falconbridge nickel plant, which meet their own needs.

Electricity supply is generally very poor. Recent completion of repair work at several power stations has enabled CDE to increase its energy capacity. In September 1991 despite its 1200MW installed capacity, CDE's output was approximately 400MW, compared with demand of 800MW, resulting in prolonged blackouts [1]. As a result of continuing problems, many companies have installed their own (often inefficient [13]) electricity generators (run on gasoline or diesel), but worsening fuel shortages in 1990 made private generation difficult to sustain [2]. Electricity-generating units in the private sector account for around 15% of installed capacity in the country's power system [13].

In 1991, a management contract was signed between the CDE and Unión Fenosa, a Spanish company specialising in the administration of electricity enterprises. The US$8.3 million

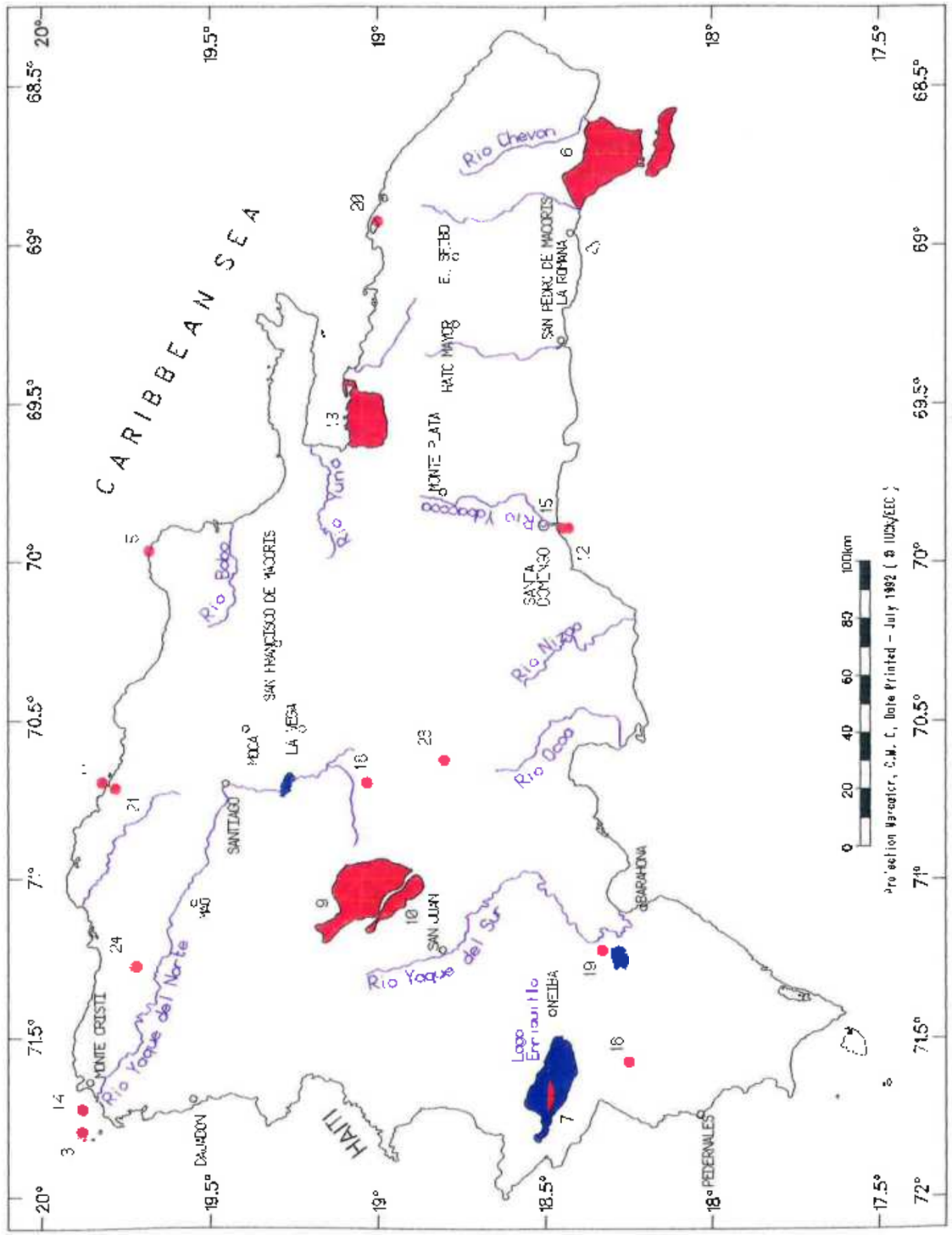


Figure 4. Protected Areas of Dominican Republic:
See text and Annex II for further details.

contract is part of the rehabilitation programme for CDE's generating, transmission and distribution systems, financed by a loan of US$148.8 million from the Inter-American Development Bank. CDE also proposes to expand its generating capacity by 250MW. Venezuela has offered to supply two used power plants to help meet these needs [1, 26].

It has been estimated that an investment of around US$1.6 billion is needed over the next five years to provide a satisfactory system of power generation and transmission. Investments so far approved by the electricity industry's development authority amount to about US$600 million. New projects — approved or planned — would add more than 900MW of generating capacity [1].

New power generation projects include Steam Power Plants I and II (Santo Domingo); Arroyo Barril Steam Power Plant I; Boca Chica Co-generation Plant, and Río Haina Co-generation Plant. Each of the Santo Domingo Steam Power Plants would consist of a 125MW coal burning unit and, together, would generate power equivalent to 7% of current domestic consumption. The cost of each plant is estimated to be US$146 million. The Arroyo Barril Steam Power Plant I (costing US$159 million) would also consist of a 125MW unit burning imported coal. The Boca Chica Co-generation Plant (US$29 million) would be a 17MW unit burning sugar cane waste products, as well as imported coal. The Río Haina Co-generation Plant (US$79 million) would comprise two 16MW power generators that likewise would use bagasse and imported coal. The government is seeking foreign financing for all of these projects [13].

The government is also seeking external funding for the Jiguey/Aguacate Hydro Power Plant, which was started in 1987 and is still far from complete. Two dams, Jiguey and Aguacate, have been designed for power houses equipped with generating units possessing a nominal installed capacity of 85MW and 52MW, respectively. The project is estimated to cost US$135 million, exclusive of investments to produce drinking water and irrigation [13].

In an effort to diversify its options for power generation, the government has granted foreign oil companies concessions to undertake exploratory drilling. In 1981 a petroleum deposit was discovered at Charco Largo, Barahona. Its potential output was estimated at 20,000 barrels per day, which could cover half of the national consumption. In September 1991 Mobil Oil announced that it was starting exploration in the Azua and San Pedro de Macoris areas, with geological and seismic surveys. A US-Dominican company, Once-Once, is to begin oil exploration in the Cibao Valley and Samaná Bay areas [1].

Timber, in the form of charcoal or leña (spirit), currently supplies more than 20% of national energy requirements, and 74.3% of domestic energy demand. The National Commission of Energy Policy (COENER — Comisión Nacional de Política Energética) estimated that for 1986 around 967km^2 of forest were cleared to satisfy the population's basic energy demand, i.e. 3.9 million m^3 of timber a year, or 0.56m^3 per person each year [10].

Demography and Urbanisation

Demographic Pattern

The Dominican Republic is divided into three regions (the south-west, the south-east and Cibao) and seven subregions, which are made up of 29 provinces and the national district (Santo Domingo, the national capital) (Fig. 1) [11].

The population has increased from 894,665 in 1920 [11] to 7.32 million in 1991 [10]. About 2.7 million (38%) are under 15 [2]. Median age went from 17.8 years in 1980 to 20.2 years in 1990 and is projected to reach 23.2 years by the year 2000 [11].

Mulattoes are considered as a separate race in official censuses and form the largest group in the Dominican Republic, accounting for about 75% of the population. Approximately 15% are classified as white and about 10% black, mostly of Haitian origin. Ethnic groups include Chinese, Japanese and other Asians [2].

The Dominican Republic has one of the lowest population densities in the Caribbean – around 151 per km^2 in 1991. Most people live in the south-eastern plain, where the sugar cane plantations and pasture lands are concentrated, or in the Cibao and Vega Real areas further north where cocoa, coffee, rice and other food crops are cultivated [3, 24].

About half the population is of working age (15-64 years). In 1989 the labour force was estimated at almost three million; an estimated 10-15% is unionised. Unemployment was then running at about 29%, while underemployment may have accounted for up to another 30% of the workforce. Some 40% of the economically active population is engaged in agriculture, 15% in industry, 12% in trade and finance and 18% in services. Income distribution in the Dominican Republic is highly skewed: the top 10% of the population receives 38.5% of the nation's revenue while the bottom 50% get only 18.5% [2].

For 1986 the school enrolment rate was 92%. This means 132,000 children aged 7-14 did not enrol in the school system that academic year. At the same time, the average dropout rate for 7- to 14-year-olds was 8% and exceeded 13% at the first grade level [13]. In 1985 the adult literacy rate was estimated at 77.3% [3]. Overall, the progress achieved in education has not been sufficient to meet the goal of full elementary school coverage nor that of increasing educational system efficiency [13].

Expenditure on education has amounted to between 10 and 14% of the budget of central government but, in real terms, the amount is declining [10].

Population growth

Population growth is declining, from 3.0% a year for 1960-1970, to 2.45% for 1985-1990. This drop reflects the effects of rural and urban family planning programmes, as well as emigration. It is anticipated that by 2020-2025 the growth rate will have fallen to 1.2% [2, 11].

The birth rate in 1989 was 30 per 1000 people, while the death rate was 6 per 1000. Some progress has been achieved since 1965 when recorded figures were 47 births and 13 deaths per 1000 respectively [2]. Infant mortality (63 per 1000 live births in 1988) [3] has declined significantly over the past two decades despite marked deterioration in living conditions. The change is attributed to oral rehydration and mass vaccination programmes [11]. The death rate was estimated at 7.5 per 1000 inhabitants for 1980-1985, a decline from 8.4 in 1975-1980. Under-registration of deaths is widespread.

The Dominican Republic was one of the first countries in the region to have a policy to reduce fertility and population growth. The present government's policy is also to decrease the growth rate, but it has yet to formulate and implement a comprehensive set of measures to do so. Considerable work has already gone into developing family planning services [15].

Life expectancy, estimated at 66 years between 1985 and 1990, is projected to reach 72.4 years around 2020-2025 [15].

Internal and external migration

Damage caused by Hurricanes David and Frederick (in 1979) dramatically increased rural to urban migration and exacerbated a housing shortage [8].

Interregional and rural-urban migration are increasing as the cattle farming ("*agropecuario*") sector becomes less important to the economy, while manufacturing, tourism, construction and service sectors and the free trade zones expand [10]. Many small farmers, for instance, would rather search for employment in the cities than continue subsistence agriculture. The government has drawn up guidelines for balanced regional development and agrarian reform to reduce urban immigration [15].

At an international level, Dominicans emigrate to the USA and Puerto Rico while, historically, Haitian labourers have constituted the major source of immigration. There is no systematic registration of these population movements [10], although net migration out of the country for 1985-1990 has been estimated at 78,500 [11]. The government considers both immigration and emigration to be too high [15].

Extent, density and distribution of urbanisation

In 1990, 52% of the population was urban, compared with 35% in 1965 [2]. The UN predicts that by the year 2025, 79.6% will be urban [15]. The population of the district including the national capital increased by 5.4% a year between 1970 and 1981 and accounted for 32.2% of the total population in 1988 [11]. The most recent available population estimates for some major towns (1988) are given in Table 4.

Table 4. Population estimates of major towns (1988) [2]

Town	Population
Santo Domingo	2,200,000
Santiago	467,000
La Vega	189,000
San Francisco de Macoris	162,000
San Pedro de Macoris	137,000
La Romana	136,000

Health issues

Health statistics are unreliable due to incomplete registration of births and deaths [8]. According to available data for 1985, 13% of registered deaths were not medically certified (in 1966 the figure was 75.1%). Registered morbidity corresponds only to diseases for which reporting is compulsory. Registration therefore suffers from shortcomings in coverage and quality [11].

The main known causes of death are heart disease, perinatal effects, cerebrovascular diseases and accidents (which show a sharp upward trend). The disease most frequently reported as a cause of death is gastroenteritis. The many reports of dysentery, hepatitis, typhoid and paratyphoid fever, and the high levels of intestinal parasites demonstrate the prevalence of waterborne and food-borne diseases and deficiencies in sanitation [11]. Malnutrition is very common in children [8]. The Dominican Republic has the sixth highest number of AIDS cases in Latin America and the Caribbean after Mexico, Brazil, Haiti, Honduras and Colombia. By December 1992 WHO had recorded 1809 cases of AIDS [44].

Basic services such as drinking water supplies and waste treatment are inadequate, and fail to keep up with population increase. A government report states that only 27% of population are currently connected to a sewerage system, but UN figures suggest that for 1983-1985 some 66% of the population had access to sanitation services [41]. Likewise, government sources suggest that fewer than 50% of the population now have direct access to piped water, while the UN reports that this figure was 63.8% of population in 1983-1985. Government efforts to improve the current water supply include the Planar IV project, which aims to provide 150 communities and 130,000 people with 19,000 connections through 50 new aqueducts. This would give access to piped water to about 10% more of the Republic's rural population. The estimated cost is US$20 million [13].

Hospitals in the public sector are short of accommodation (approximately one bed per 1000 people). The deficiencies in outpatient care are even greater (one consultation per inhabitant per year for the entire health system). The Ministry of Public Health and Welfare (SESPAS) has increased its workforce. There are now some 5.7 Ministry physicians per 10,000 people (1800 inhabitants per physician), not including interns [11].

About 9% of the national budget goes to health care services, which reach an estimated 80% of the population (1980-1987). In real terms, however, the health budget declined by 50% during 1981-1990. In theory, SESPAS covers 83% of the population, but recent estimates indicate that as many as 1,750,000 inhabitants may be without access to any health care services [8, 10].

Government policy is to improve and expand the national health service system to make it more effective, efficient and equitable; to upgrade the administration and technical quality of the health service network; to develop critical administrative sectors; and to promote health research. Priority target groups are children, women of reproductive age, breast-feeding women and workers. The water supply in targeted rural areas has been improved by the construction of new wells and home latrines in communities where the government is promoting health [15].

ANALYSIS OF POLLUTION AND DEGRADATION PROCESSES

Water Pollution and Water Shortage

Some surface waters suffer from salinisation (particularly serious in the north-west, where salt concentration in the water ranges from 0.61g/litre to 1.2 g/litre). Other problems are waste from farms and industries located in the rural zone; agrochemical residues (high pesticide levels are present in the soils of intensively farmed areas [7]); and waste from urban and coastal areas [10].

Sewage is discharged untreated into watercourses and the ocean. Inadequate collection of solid waste leads to dumping in streets and untended areas, clogging of the sewage system, and the spread of rodents, flies and other disease-carrying vectors [11].

A more general problem is the high load of suspended solids carried by rivers arising from slash-and-burn agriculture, an absence of soil conservation measures, and poor road design and construction. Watershed erosion in the order of 100-500 tonnes/ha/year is leading to rapid sedimentation of hydro-electric reservoirs, aqueducts and irrigation projects [8].

Many wetlands have disappeared in recent years as a result of drainage for agriculture and pasture. Extraction of sand and the exploitation of salt at saline lagoons have also led to their destruction. Coastal wetland areas have suffered from the felling and burning of mangroves and other vegetation bordering lagoons, as well as from excessive fishing. In recent years, the country's wetlands have been exposed to new threats such as the dumping of industrial wastes and the establishment of shrimp farms in mangrove forests. On the other hand, following Hurricane David in 1979, some wetlands increased in size, including Lago Enriquillo, currently the Republic's largest wetland. Because of the lack of information on wetlands the full extent to which these ecosystems are threatened cannot be determined [5].

Soil Erosion and Degradation

In mountain valleys, deforestation and slash-and-burn agriculture have led to loss of the topsoil (up to 3cm a year in some areas), leading in turn to declining soil fertility. In cattle-ranching areas, where the soil is always susceptible to erosion, ranchers have failed to practise conservation measures which would arrest degradation. Finally, in some irrigated areas, salinisation and loss of soil structure, largely a result of mismanagement, are affecting 52% of soils [10, 14].

The potential for serious flooding has increased owing to deforestation and subsequent erosion. Without stabilisation, river banks are eroded and now overflow relatively frequently during the rainy season (June to October).

In the highlands, continuing demand for charcoal and firewood, and the consequent deforestation, have also led to top soil erosion, leaving the affected areas barren and rocky [8].

Large hydro-electric and irrigation dams are built with little thought to protecting watersheds. The lakes created behind these dams are silting at more than twice the anticipated rate. Many dams and canals now operate at less than 50% of their planned capacity [7].

Deforestation

In 1900 an estimated 80% of the national territory was forested. By 1981, this figure had plummeted to 18.3% and has since declined even further, to around 13.2% [10]. Most of the country's timber is now imported, costing US$30 million a year [10].

The National Technical Forestry Commission (CONATEF), the National Forest Directorate (DGF) and the National Parks Directorate (DNP) are the institutions most responsible for the protection and management of the country's forests. But from 1983 to 1987, official funding for these agencies amounted to a mere 0.3% of the government budget [7].

Evergreen forests, broadleaved rain forests and cloud forests are now seriously threatened in the Dominican Republic. What little is left now is dispersed throughout the country. Most of the semi-deciduous forests (dry forests) have been altered considerably by charcoal production. The pine forests are better represented and have fewer problems because they are mainly located on poorer soils and at high elevations and are thus less affected by agriculture and fires [12].

Extensive deforestation has been caused by sugar cane cultivation as well as by migration to previously state-owned land in the hill areas. This land was occupied and cleared mainly during the 1960s when decreasing income from coffee crops and the rumoured availability of the land prompted new settlements. There is practically no forest left in these areas and crop yields have dropped by 50% in some places since immigration began. The pressure from agriculture is most noticeable in dry forests in the west and humid forests in the north-east [4].

Slash-and-burn farming, fuelwood collection and charcoal production have further contributed to deforestation [8]. In 1986, areas for charcoal production were demarcated. Since then production and transport have been controlled [10]. DGF, however, monitors only about 20% of the estimated annual production of 4.8 million sacks. Management of tree-cutting for charcoal is non-existent.

Grazing also significantly damages the country's forests. Dry forest lands are used as open range for goats. This reduces tree cover and contributes to erosion. Increasing markets for beef and beef products, both local and in the US, have encouraged the conversion of forest lands to pasture [7]. Forest land cleared for pasture accounted for 78% of the forests cleared between 1972 and 1986 in the western half of the Dominican Republic [16].

One study [16] has attempted to measure the rate of deforestation in the western half of the country by comparing satellite images taken in 1972, 1979 and 1986. The results suggested a 32% decrease since 1972. Productive forests, which covered 28% of the area studied in 1972 (6658km^2), had declined to 19% by 1986. During this period, 2115km^2 of hardwood and pine forests disappeared. This translates into an annual deforestation rate of 142km^2/year, and does not include the subtropical dry and subtropical thorn forests in the study area. The dry forests were cleared at a rate of 106km^2/year during the same period, giving a combined deforestation rate of 248km^2/year [16].

The World Resources Institute has estimated an annual deforestation rate for the 1980s of 40km^2 a year of evergreen forest (0.6% of total evergreen forest) [14]. Since 1969 only 32km^2 of forest plantations have been established. About 70% were government-sponsored. The native *Pinus occidentalis* and the exotic *P. cribaea* var. *hondurensis* are the dominant plantation trees.

Despite rampant deforestation and the obvious need for tree plantations to reduce erosion and help rehabilitate sites, USAID had concluded that a reforestation programme of the scale required would be hampered by a serious lack of technical expertise, the absence of incentives and guarantees for private reforestation efforts, and a lack of awareness for the need for reforestation. Both traditional plantations and tree planting as a component of agroforestry can play an important role in erosion control and site rehabilitation. But such activities must be considered part of an integrated land management programme. Plantations of fast growing trees of high calorific value could appreciably lessen the abusive cutting of dry forests for charcoal. Only a few studies of the potential and the need for fuelwood plantations are under way. Because of the ecological importance of the remaining pine forests as critical watershed catchments for the major rivers, they should not be considered a significant source of industrial wood.

Biodiversity

The loss of natural habitats for agriculture, livestock and charcoal production is the major threat to fauna and flora, both within and outside protected areas. As a result, many native species are threatened [7].

The government has been unable to match its creation of parks and reserves with structures to administer and protect these areas from illegal entry and exploitation. Park guards are underpaid and inadequately trained. Programmes to study these areas are hampered by DNP's lack of funds, inadequately trained professional staff and poor organisation. Plans were written for two national parks, but the Directorate's limited resources, both financial and physical, have prevented their implementation. Other government agencies often implement programmes which compound these problems by encouraging the invasion of parks and reserves by farmers [7]. Monte Cristi National Park in the north-west is considered the Republic's most threatened park.

Dunes, lowland rivers and natural dry forests are scarcely represented in protected areas [12]. Efforts made to conserve areas outside the existing system of national parks and scientific reserves have not been successful. The government's attempts to control the exploitation of biological resources outside protected areas through bans and regulations are not adequately enforced [7].

The Dominican Republic has some 70 fish species, 60 amphibians, 141 reptiles, 254 birds and 33 mammals. Of these, 53% of the fish, 97% of the amphibians, 80% of the reptiles and 15% of the birds are endemic. The reptiles, with 327 sub-species show the highest diversity. There are many introduced species of fish and mammals. The majority of the vertebrate species are considered common or very common. The distribution of most vertebrates is increasing, except for the amphibians, which tend to be restricted to certain regions. For reptiles, range restrictions are found on the sub-species level [12].

A recent survey of 17 beaches recorded the presence of the Caribbean endemic American crocodile (*Crocodylus acutus*), found only at two sites in the Republic. Among marine turtles, the leatherback (*Dermochelys coriacea*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and loggerhead (*Caretta caretta*) have been recorded. The area extending roughly from the Laguna Limón to the Cabo Engaño is said to be an important turtle-nesting area. The Caribbean manatee (*Trichechus manatas)* occurs mainly on the north and south-west coasts and has been reported from the *Thalassia* beds in Puerto Viejo [6].

Many animal species, such as the crocodile, manatee and turtle, are under extreme pressure and over-exploitation. The American crocodile is included on Appendix I of CITES which prohibits all commercial trade in listed species. It is, however, still hunted indiscriminately for its meat and for use as an aphrodisiac, and its eggs are frequently plundered. The crocodile's habitat is also suffering from the increasing salinity of Lake Enriquillo, and from the clearing of mangroves and lake shore vegetation for charcoal production and agriculture. Fishing nets are another source of constant danger [7].

Waterfowl populations suffer from activities such as the use of pesticides, egg-collecting (particularly the eggs of species of Ardeidae, Threskiornithidae, Anatidae, Rallidae and Laridae), excessive hunting practised without any effective control, mining of sand and stone for construction, and tourism development [5].

Altogether, 89 species and sub-species of fish, reptiles, birds and mammals are considered threatened. Of these, 15 are classified as endangered, 37 vulnerable and 13 rare. The exact status of the remaining 24 species/sub-species is uncertain. Fourteen of these threatened species (13 reptiles and one bird, *Burhinus bistriatus*) do not live within protected areas [12].

The national flora is estimated at 5600 species, of which about 36% are endemic. A preliminary listing has indicated that 277 species are threatened or in danger of extinction. Among the endangered plants, the endemic canelillo (*Cryptorriza haitiensis*) and the palma cacheo (*Pseudophoenix elomanii*) are being eliminated by collectors for commercial purposes. Experts from the Jardín Botanico recently discovered *Acacia cocuyo* and a new species of Momosaceae, *Uboinga zanonia*, found only on the Loma María García. These newly-discovered species are threatened by the activities of local charcoal producers. Similarly, the

caobanilla (*Stahlis monosperma*), which grows only along the eastern banks of the Soco River and a few other locations around Higuey, is being cut by charcoal producers. It does not regenerate or reseed easily [7].

Marine Environment and the Coastal Zone

Human activities are having a noticeable effect on the coast. Many of the low-lying coastlines have been converted to coconut plantations, paddy fields and livestock areas [6]. Unless action is taken, inadequate planning of facilities for the treatment and disposal of waste at coastal tourist developments will eliminate many of the country's near-shore reefs and create health risks [7].

Poor coastal management in areas such as Miches has led to erosion and severe damage to the adjacent reefs through high sediment runoff [6]. Dredging for coralline sand has been carried out at Puerto Viejo (west of Santo Domingo) and at Boca Chica in Bahía de Andrés. The popular recreational beach at Guibia near Santo Domingo has deteriorated, largely due to dredging and pollution of Río Ozama which has its outfall here. At Puerto Viejo, dredging activities have taken place in the vicinity of the reefs for the expansion of the harbour. There is no information on whether this has caused damage to the reefs, but mangroves have been destroyed. On the south coast, tourism, diving and sport fishing have resulted in damage to reefs. Spearfishing is also severely affecting some sites [6].

Coastal developments for tourism are eliminating many mangrove forests which are essential for maintaining the productivity of the country's artisanal and pelagic (open seas) fisheries. Mangroves have also been over-exploited for tannin, charcoal and construction wood. It has been estimated that 50% of the mangroves at Puerto Viejo and adjacent islets were destroyed between 1919 and 1962 [29]. Extraction of materials for construction is affecting river beds, beaches and dunes. The construction of tourist facilities on beaches used by marine turtles for laying eggs will doubtless affect species population levels [7].

The use of compressors for extended underwater spear-fishing, together with the collection of shellfish and corals (for sale as ornaments and for lime-making), is depleting many marine plant and animal populations [6, 7].

The coastal and marine regions most severely exploited for fishing are the Banco de la Plata, Banco Monchoir, Arracife, Buen Hombre, the zones around Cabarete and Nagua, the Bahia de Samaná, and along the north shore of the Samaná peninsula around Las Terrenas. Other affected areas include Sabana de la Mar and Miches, the bays of Cabeza de Toro and Punta Cana, Catuan, Caballo Blanco and the Bajos de Catalina [7].

Urban Environment

Overcrowding in cities and the demand placed on urban facilities have been major problems since the 1930s. Problems are particularly acute in suburbs where average density may be as high as 28,773 inhabitants/km^2 [10], resulting in the growth of impoverished slums around

urban centres and creating an enormous demand for basic services that cannot be satisfied. There are many "*barrios*" (marginal urban settlements), especially in Santo Domingo, and usually in dangerous, undesirable zones such as steep ravines and low-lying river banks [8].

Lack of housing is a major problem; the Dominican Institute for Population and Development Studies (Instituto de Estudios de Población y Desarrollo) has estimated that there is a deficit of over 350,000 houses [32] (Table 5). Nearly three-quarters of Santo Domingo's families live in low-income marginal housing. Of these, 34% live in *cuarterias* and *trapatios*. *Cuarterias* are rows of attached units consisting of one or two rooms. *Trapatios* are small dwelling units constructed at the back of other houses. Both these housing types are generally located near the centre of the city.

Table 5. Shelter inventory (and percentage of total) in the Dominican Republic according to physical conditions and location (1990) [32]

Condition	Cibao	South-east	South-west	Total
Irreparable	142,116 (40%)	131,632 (36%)	86,758 (24%)	364,550
Can be improved	202,655 (42%)	247,156 (52%)	28,876 (6%)	478,263
Adequate	84,583 (31%)	176,620 (64%)	14,438 (5%)	272,019

In recent years, there has been a continuing decline in local services in all urban areas. Despite the abundance of natural water supplies, safe drinking water is scarce. Water is generally obtained from public faucets or bought from neighbours or water vendors. Official sources have estimated that some 70% of the water supply to urban areas comes from the subsoil, however, and contains high levels of salt and microorganisms that are dangerous for human consumption [32].

Sanitary waste disposal and trash collection systems are lacking in the majority of urban centres. Since many cities in the Republic are coastal (Santiago, San Juan, La Vega and San Francisco de Macoris excepted) sewage discharge to the sea has been permitted without concern [29].

Energy Issues

Three basic problems affect the energy sector in the Dominican Republic: indigenous energy resources are limited and costly to develop; energy production, transformation and end-use are inefficient; and the legal/regulatory/institutional framework and policies are inadequate. Weak economic performance has curtailed energy supplies and has depressed the efficiency of energy end-use, while deficient energy management has dislocated economic activity [31]. Considerable environmental degradation has resulted from mismanagement, particularly deforestation (and soil erosion) and pollution (emissions from the combustion of hydrocarbons in the Santo Domingo/Haina Metropolitan area).

To put the energy sector on a sounder footing, the government needs to pursue a comprehensive and well-focused strategy, concentrating initially on meeting essential energy requirements and then developing a long-term strategy for management. Environmental legislation and standards also need to be re-examined and strengthened.

Industry

Three institutions, INAPA, CAASD and CORAASAN are responsible for controlling municipal pollution but, at the present time, none is responsible for controlling industrial or agricultural pollution. Mining is currently the only industry subject to environmental controls. Fisheries legislation requires that any related industry control its waste water discharge, but little attention is paid to this law [29].

Most revenue (about 70%) is generated by agriculture — primarily sugar, furfural, molasses, tobacco, food and beverages. The only heavy industries are mining (bauxite, ferro-nickel, gold and silver), cement, steel, petroleum refining and electric power generation [29].

Several pollution problems are widely recognised: particulate or smoke emissions from the Falconbridge Dominicana Corporation (FDC); cement plant and smoke emissions from Metaldom (the Dominican Metallurgical Complex) in Santo Domingo; suspended solids and sulphur oxide emissions from steam electric power generation using high sulphur bunker fuel oil; and the majority of waste waters from food processing, soap and detergent production and similar operations with minimal waste recovery operations.

Major polluters are usually state-owned industries that are under-capitalised and use old technology. These include sugar processors, cement manufacturers, oil refining plants, electricity generation units and gold and silver mining enterprises. Multinational companies, in contrast, generally have effective, state of the art technology for controlling emissions and waste. They also make a point of being able to respond to emergency situations rapidly and expertly [29]. This fire-fighting, spill-control and storm-protection capability needs to be recognised and used by the government.

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NOTE ON DATA SOURCES

Every effort has been made to ensure that the information in this Environmental Synopsis is as detailed and accurate as possible. Figures given in standard sources often differ, sometimes considerably, for example in relation to population, energy capacity, education, GDP growth rate, industry, forest extent and even total land area. In such cases, the figure most frequently cited, or an average of those most frequently cited has been used. Wherever possible, original data sources have been used as a reference or, failing that, data have been checked against several other sources.

A number of publications are recommended for further in-depth reading on a particular topic. These include the regular country reports of the Economist Intelligence Unit [1,2, 26] which provide a well-balanced review of the political (historical and present) and economic situations as does the Europa Handbook [3]. A wide selection of useful statistical data are to be found in [2, 3, 4, 9, 14, 15, 17, 18, 19, 20, 21, 22, 23, 35, 36, 37, 38, 39, 40, 41, 42 and 43]. Information on biodiversity, deforestation and wildlife issues have been obtained from a number of publications [4, 5, 6, 28, 29]. Demographic, health and similar data have been taken from a wide range of sources within the United Nations (including WHO and UNICEF).

Even given such a broad coverage, there remain a large number of gaps in the information which cannot be completed at the present time. For example, there is relatively little information concerning the country's biological resources and efforts to conserve them. The government agencies responsible for these resources have kept poor records of conservation programmes they have undertaken. A whole panoply of international and non-government assistance organisations have neither left records of their activities, nor assured for adequate follow-on once their projects terminated. Moreover, most of the institutions involved in the study, protection and management of the country's biological resources work independently. Information is dispersed and is not easily accessed, making it difficult to obtain a clear assessment of the country's biological resources and their diversity [7].

One of the prime objectives of this overview has been to highlight gaps in current information in the hope that government and development agencies alike will take the need for fuller information into consideration when planning and implementing future projects.

ANNEX I

Vegetation Pattern of the Dominican Republic (See also Fig. 3)

The vegetation patterns represented here are the Holdridge Life Zones. Boundary information for the conservation areas of the Dominican Republic have been digitised from a published tourist map *Mapa de la Republica Dominicana* at a 1:672,000 scale. The source map covers only national parks.

Digitised data are held at the *WCMC Biodiversity Map Library*, WCMC, 219 Huntingdon Road, Cambridge, CB3 ODL, UK.

ANNEX II

Protected Areas of the Dominican Republic (See also Fig. 4)

Map Reference	Protected Area
3	Cayos Siete Hermanos Bird Sanctuary
5	Cabo Frances Viejo National Park
6	Del Este National Park
7	Isla Cabritos National Park
9	Jose Armando Bermudez National Park
10	Jose del Carmen Ramirez National Park
11	Littoral Norte (Puerto Plata) National Park
12	Littoral Sur (Santo Domingo) National Park
13	Los Haitises National Park
14	Monte Cristi National Park
15	Parque Submarino la Caleta National Park
16	Sierra de Bahoruco National Park
18	Ebano Verde Natural Scientific Reserve
19	Laguna del Rincon Scientific Reserve
20	Lagunas Redonda y Limon Scientific Reserve
21	Loma Isabel de Torres Scientific Reserve
23	Valle Nuevo Scientific Reserve
24	Ville Elisa (Dr Orlando Cruz Franco) Scientific Reserve

ACRONYMS

CBI	Caribbean Basin Initiative
CCA	Caribbean Conservation Association
CDE	Corporación Dominicana de Electricidad (Dominican Electricity Corporation)
CEBSE	Centro para Conservation y Ecodesarrollo de la Bahina de Samaná y su Entorno, Inc (Centre for Conservation and Ecodevelopment of the Samaná Bay and Environs)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMC	Center for Marine Conservation
COENER	Comisíon National de Política Energética (National Commission for Energy Policy)
CONATEF	Comisíon Nacional Forestal (National Technical Forestry Commission)
DGF	Dirección General de Foresta (National Forest Directorate)
DNP	Dirección Nacional des Parques (National Parks Directorate)
DVS	Departamento de Vida Silvestre (Wildlife Service)
DRP	Departamento de Recursos Pesqueros (Fisheries Service)
CEC	Commission of the European Communities
FEDOMASEC	Federación Dominicana de Associaciones Ecológicas (Dominican Federation of Ecological Associations)
ha	hectare(s)
IAD	Instituto Agrario Dominicano (Dominican Agricultural Institute)
IADB	Inter-American Development Bank
IFZ	Industrial Free Zone
km	kilometre(s)
MAB	Man and the Biosphere Programme of UNESCO
MW	Megawatt(s)
NGO	non-governmental organisation
PRONATURA	Fundacíon Fondo para la Naturaleza (Nature Foundation)
SEA	Secretaria de Estado de Agricultura (National Agricultural Secretariat)
SESPAS	Ministry of Public Health and Welfare
TNC	The Nature Conservancy
UN	United Nations
USAID	United States Agency for International Development
WWF-US	World Wildlife Fund (United States)

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