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Coastal Setbacks in Latin America and the Caribbean

A Study of Emerging Issues and Trends that Inform Guidelines for Coastal Planning and Development

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This Technical Note was prepared by the Environmental and Social Safeguards Unit (VPS/ESG) of the Inter-American Development Bank (IDB). ESG works to promote the environmental and social sustainability of Bank operations. It collaborates with project teams to execute the IDB's commitment of ensuring that each project is assessed, approved and monitored with due regard to environmental, social, health and safety aspects, and that all project – related impacts and risks are adequately mitigated or controlled. ESG also helps the Bank respond to emerging sustainability issues and opportunities.

The goal of this study was to compile information on the use and effectiveness of coastal setback areas as a development planning and management tool in the 26 borrowing member countries of the Latin America and Caribbean Region. In addition, information is also provided on international best practice in the design and implementation of setbacks.

The principal authors of this document were Murray C. Simpson, Colleen S.L. Mercer Clarke, John D. Clarke, Daniel Scott and Alexander J. Clarke. Helpful inputs and comments were provided by Hilary Hoagland-Grey, Denise Levy, Natasha Ward, Michele Lemay and Greg Radford.

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Executive Summary

The Inter-American Development Bank (the Bank, the IDB) is the main source of multilateral financing and expertise for sustainable economic, social and institutional development in the Latin America and Caribbean Region (LAC) (IDB 2012). To help the Region achieve greater economic and social progress, the Bank has identified four sector priorities to guide its efforts:

- social policy for equity and productivity;
- institutions for growth and social welfare;
- competitive regional and global integration; and
- protection of the environment, response to climate change, promotion of renewable energy, and food security.

The Bank has a strong commitment to providing support for sustainable, climate-compatible development that:

- reduces poverty and social inequalities;
- addresses the needs of small and vulnerable countries;
- fosters development through the private sector;
- addresses climate change, renewable energy and environmental sustainability; and
- promotes regional cooperation and integration.

Bank investments in tourism and other coastal development projects have been on the rise, generating an interest in the development of instruments and tools that would more effectively inform Bank staff on critical issues, and support the management of the environmental and social risks of the Bank's portfolio. Coastal areas, which are home to the majority of the population of the LAC Region, are challenged by rising populations, sprawling and sometimes unplanned development, and the associated pressures of pollution, overexploitation of marine and freshwater resources, loss of biodiversity, severe storms, and the longer-term threats of climate change and attendant sea level rise.

The goal of this study was to compile information on the use and effectiveness of coastal setback areas as a development planning and management tool in the 26 borrowing member countries of the Latin America and Caribbean Region. In addition, information is also provided on international best practice in the design and implementation of setbacks. The following conclusions are based on the situation analysis of the LAC and the available international literature:

- The scientific literature and planning practice community conclude that coastal setbacks have considerable potential for use as an effective tool to avoid and/or to mitigate the damages inflicted by the sea upon development infrastructure, and the damages inflicted by inappropriate human development on coastal and marine environments.
- Given the potential additional stresses from increased coastal development and climate change, coastal setbacks offer considerable potential as an effective planning tool to avoid and/or minimize damage from current coastal hazards (e.g. inundation, erosion) while proactively planning to reduce the potential risks to human safety and critical economic infrastructure in the future. Setbacks are also a prudent mechanism for lending institutions, insurers and government agencies to manage uncertain (**and evolving**) liabilities related to approvals of coastal development inappropriate for future climatic conditions.
- A comprehensive review and consultations with regional experts found few instances in the Latin America and Caribbean Region where coastal setbacks have been effectively employed as a mandatory requirement for coastal development. In many of the Bank's borrowing countries, there are no commonly enforced requirements for coastal setbacks. Even where setback policy and/or legislative instruments had been in place for a long period of time, implementation had been challenged by economic, political and social pressures. Exceptions (or variances) to specified minimum setbacks are widespread. Liabilities for damaged or abandoned coastal properties remains uncertain in many jurisdictions.
- Among the countries of the LAC Region, there are no consistent policies or instruments that require coastal setbacks for new or existing development. Within a few small island states (e.g. St. Kitts and Nevis, Anguilla) a shared approach for the development of local coastal setbacks for development has faced challenges in implementation.
- In the LAC Region, for the most part, planning authorities at the national level were the identified authority for the development and implementation of coastal setbacks. This situation varied according to the structure and complexity of the country's bureaucracy, the purpose of the setback policy, and the capacity of the responsible authority to ensure

that the setbacks were observed. Almost no information was available from the LAC region on the effectiveness of setbacks in managing coastal development (e.g., proportion of properties meeting or exceeding minimum setbacks, proportion of exceptions/variances granted, compliance with exception conditions, longitudinal evaluation of damages to properties complying with minimum setbacks, granted with exceptions or not in compliance with either).

- Coastal setbacks have their greatest potential for effectiveness when integrated with other planning and management tools such as zoning, coastal planning and design guidelines for development, building code requirements, conditions for financing and insurance, and emergency measure planning. There was little information in the LAC Region that demonstrated where setbacks had been effectively integrated into other planning and management tools for coastal development. In several countries, a form of setbacks had been a derivative of colonial administrations that reserved an area of the backshore for use of the 'Crown' (e.g. St. Lucia, Costa Rica). Even where coastal setbacks were an element of planning policy, universal application appeared to be difficult (e.g. Uruguay).
- Coastal setbacks are a significant instrument in the coastal planning policy of Cuba, where they are used in conjunction with other planning tools, such as no-build area designations and buffers to protect sensitive environments and to manage development.
- Global practice has demonstrated the difficulties in establishing a single setback distance that accommodates for erosion, inundation, the protection of significant coastal assets, and the provision of public access, and also includes planning for sea level rise and the effects of severe weather events. In the Mediterranean, where the Protocol on Integrated Coastal Zone Management of the Barcelona convention contains a minimum 100m setback for new development (with few exceptions), the conditions for development planning are left to the individual nations. Calculating setback distances for individual properties has benefits when considering a local development proposal, but may prove too cumbersome for application across an entire coastline.
- Setback design is particularly challenged by the need for decades of data on local erosion rates, the inability to predict the extent of erosion and inundation impacts attributable to a severe weather event, and the need to plan for sea level rise and increasingly severe and frequent storms.

- Many countries face the same implementation challenges as the LAC Region, where conflicting social, political and economic demands exert significant pressure against the use of mandatory setbacks and their long-term benefits. However, the Barcelona Convention in the Mediterranean, the setback instruments proposed by Australia and New Zealand, and the determination of individual states within the United States to apply coastal setbacks as a planning tool, as a means to protect coastal habitats, and a mechanism to force private responsibility for coastal hazards in order to reduce future public liabilities for damage compensation, and in some cases cope with the future threat of sea level rise, are all examples of key trends in the evolving use of coastal setbacks as tools for current and future coastal management.
- Government efforts to incorporate climate change and sea level rise into coastal planning (including zoning and setbacks) have often met with legal challenges. These international leaders offer potential lessons learned for LAC countries and can inform future development of guidelines within the IDB.
- Studies by the World Bank (Dasgupta et al. 2008) and UNDP (see Simpson et al. 2010) revealed the significant risk posed to coastal properties in the Caribbean. Unless a clear policy has been set to guide coastal planning for climate change (e.g. protect, accommodate, retreat), the usefulness of a coastal setback will come into question with each severe weather event. Planning for a managed retreat from high-risk areas that are or will be affected by increased erosion and flooding requires commitment to policies that prevent new construction and require landowners to plan for obsolescence of existing structures (e.g. New Zealand).
- Within the LAC Region there is a clear and present demand for leadership in the development of policy and instruments for the design and effective implementation of coastal setbacks. This situation is especially critical given the impending financial liabilities due to severe weather, erosion and inundation that have been calculated for coastal infrastructure, and especially for the tourism sector. Much can be learned from the experiences of countries within the LAC Region and abroad, but effective implementation also requires consultation with government staff, planning and engineering professionals, the banking and insurance sector and representatives from private sector developers and tourism.

While on the surface the design and implementation of a coastal setback may seem a relatively straight forward planning and management task, in reality many efforts to implement coastal setbacks are overtaken by the complexities inherent in coastal environments, by conflicting values for coastal lands and resources, and by the need to promote tourism development in nearshore areas. Despite these complexities, the economic, environmental and social benefits of professional design and thoughtful implementation of setbacks should outweigh the short-term benefits of relatively un-controlled development in coastal areas.

This report provides in depth information on coastal setbacks, it also gives recommendations and guidance on coastal setbacks and identifies a series of key questions to guide bank staff, investors, developers and other stakeholders in the assessment and implementation of coastal setbacks. The report also provides recommendations for the way forward in order to better integrate the consideration and use of coastal setbacks into IDB processes in order to protect coastlines, investors, developers, communities, governments, environments and investment in LAC coastal infrastructure. There is an immediate need to work collaboratively with government planners and regulators, the professions (planning, engineering, architecture, landscape architecture), the finance and insurance sector and the private sector to develop a useful Guideline for the Design and Implementation of Coastal Setbacks in the LAC. Through collaborative effort, such a Guideline could do much to build on existing knowledge and experience, to identify and provide effective alternative solutions to development pressures, to facilitate the identification and mitigation of risks, and to assist countries in the Latin America and Caribbean Region with the development of policy and effective enabling legislation. The Guideline could also provide useful direction to developers, lenders and insurers to improve their proactive capacity to reduce the risks and liabilities for damage to property, and to ensure the sustainability and the quality of the coastal environments on which their industry depends.

The opportunity for the Inter-American Development Bank to take a leadership and collaborative role in advancing knowledge and implementation of a common approach to coastal setbacks in the Region cannot be overstated. Given the Bank's major continuing investment in coastal development and in the future economies of the LAC countries, it is prudent for the institution to protect its own resources and investments, while ensuring a sustainable future for the nations it seeks to assist. The return on investment in assisting with the implementation (development and/or compliance) of coastal setbacks should be considerable as climate change and sea level rise adversely impact the coastal properties of the LAC region in the decades ahead.

1.0 Context and Rationale for the Study

The Inter-American Development Bank (the Bank, the IDB) is the main source of multilateral financing and expertise for sustainable economic, social and institutional development in the Latin America and Caribbean Region (LAC) (IDB 2012). The Bank has a strong commitment to providing support to small and vulnerable countries for environmentally sustainable, climate-compatible development that reduces poverty, fosters development and promotes regional cooperation and integration. To protect its investments and to ensure their on-going effectiveness in the Region, the Bank works to identify emerging issues, to strategically respond to new trends, and to proactively support the development of new areas of good practice and expertise. In particular, the Bank has an interest in the development of instruments and tools that effectively support proactive management of the environmental and social risks associated with initiatives within the Bank's portfolio.

In recent years, IDB investment in the tourism sector and in coastal development initiatives has been growing. The majority of the LAC Region`s population now lives within 100-200 km of the shoreline and concentrations in this area are expected to increase in the future. As coastal populations in the LAC increase, so do the pressures on already threatened coastal systems and coastal resources, accelerating the loss and/or conversion of habitats, the deterioration of water quality, and reducing public accessibility. Coasts in the region experience extreme weather events, some of which have resulted in significant erosion, sedimentation, and flooding of nearshore areas. These highly visible impacts have raised serious social and economic concerns in the affected nations.

LAC nations are not alone in facing these challenges. Throughout the world, the continuing and anticipated escalation of the cumulative impacts of population growth, rising sea levels, and extreme storms are expected to have major implications for coastal ecosystems and ecosystem services, for new and existing development, and for the economic and social well-being of local populations and businesses (Barange et al. 2010, Cicin-Sain et al. 2011, IPCC 2012, Miles 2009, Nicholls et al. 2007, Parry et al. 2007, Seraval and Alves 2011, Sherman and Adams 2010,

> ***Oceans at Rio+20,***
> **The Bottom Line**
> "Notwithstanding the commendable efforts by the oceans community, involving numerous partners and stakeholders in all sectors around the world, the conditions of oceans and coasts have continued to deteriorate—marine ecosystems are significantly degraded by a wide range of anthropogenic stressors, exposed to adverse impacts of pollution, overfishing, unsustainable coastal development, impacts from oil, gas, and minerals extraction."
> *(Cicin-Sain et al. 2011, p9, GOC/BC 2011)*

Tomlinson and Helman 2006, UN/ISDR 2004a, 2004b, UNEP 2007, 2008a, 2009a, 2009b, UNEP/ECLAC 2010, UNEP/Risø 2010). Too often within the LAC these cumulative stresses can be even more intensely felt, especially when concentrated into small areas at high demand for coastal tourism development. Given the current coastal stressors and potential future situation, it is imperative that proactive planning be undertaken so as to identify the approaches and tools best able to assist businesses, communities and countries in the formulation of effective responses that promote the sustainability of coastal environments and coastal communities (Bueno et al. 2008, Burby et al. 1999, Burby et al. 2000, CARICOM 2003, CCCCC 2009, 2011, 2012, Simpson et al. 2010).

One such planning tool is the implementation of realistic and appropriate requirements for coastal development setbacks. In general, ***coastal setbacks*** are a prescribed distance landward of a coastal feature (e.g. high water mark, dune crest, line of permanent vegetation), creating an area within which all or certain types of development are prohibited (Cambers 1997, GOV/USA/USAID 2009, IOC 2009, UNEP/CEP 1996, UNESCO 1997). When used as a coastal planning and management tool, setbacks can be applied individually, or in concert with other coastal planning instruments to control new development and to set conditions for existing structures and uses. The literature generally concludes the latter is more effective (see UNEP/Risø 2012). Setbacks can reduce the physical and economic impacts of coastal hazards, contribute to the sustainability of sensitive and ecologically important ecosystems and landforms (e.g. mangroves, wetlands, estuaries, coral reefs, sea grass beds and beach dunes), and enhance the resiliency of coastal communities through the continued support of a diversity of livelihoods, and the flow of benefits to local citizens as well as governments, landowners and the financial sector (Fish et al. 2008, GOV/USA/NOAA 2012a, IUCN 2007, UNEP/GPA 2009).

Governments and businesses throughout the world and in the LAC are reacting to the estimated costs of damage associated with intensifying coastal hazards caused by sea level rise and severe weather (Bueno et al. 2008, CCCCC 2011, 2012, Heap 2007, Keillor 2003, Nicholls et al. 2008, Simpson et al. 2010, UNEP/ECLAC 2010). As lenders and insurers become increasingly aware of the existing and potential financial liabilities associated with these projected damage estimates, there is a clear and present need for planning and design that proactively addresses and manages the risks to property, to environments and environmental services, and to human safety and well-being (CCRIF 2011, Sussman and Freed 2008, World Bank 2008, Yohe et al. 2011).

To advance our understanding of the challenges in development and implementation of coastal setbacks as a planning tool for application by the Bank in the Latin American and Caribbean region, the goals of this report were to:

- gather available information about the use and effectiveness of coastal setbacks internationally, and in a selection of the borrowing members in the LAC Region of the IDB (Section 4), and
- provide the Bank with guidance on the development and application of coastal setbacks, and other coastal planning tools that would support decision-making by IDB staff (Section 5); and to
- identify to the Bank opportunities to work with countries to develop, enforce or enhance the use of these tools (Section 8 – Recommendations).

2.0 Coastal Development and the Challenge of Climate Change and Sea Level Rise

> *"For the last quarter century, scientific assessments have concluded that regardless of possible policies to reduce emissions of greenhouse gases, people will have to adapt to a changing climate and rising sea level " (GOV/USA/EPA 2009, p139)*

As early as the late 1980s, the international community became engaged in planning for the impacts of climate change on environments and human communities (IPCC 1990). Since that time, knowledge of the impacts, both current and future, to coastal environments has been steadily improving. The International Panel on Climate Change (IPCC) has concluded that coasts throughout the world are already experiencing the adverse effects of sea level rise and severe weather (IPCC 2007a, 2012, Nicholls et al. 2007, Scott et al. 2012a). It is expected that the risks to coastal environments and communities will continue to increase over the coming decades, exacerbated by ongoing development, resource exploitation and increasing populations (IPCC 2007a, 2007b, Nicholls et al. 2007, Parry et al. 2007).

While the unavoidability of sea level rise is now accepted in the scientific and international community, planning for impending change continues to face conflicts with existing development policies and practices, to place increasing demands on already limited institutional capacity, and in some cases to challenge established societal views and expectations about access to coasts and coastal resources. While it is generally accepted that proactive adaptation costs will be much less expensive than reactive responses and recovery, inaction on the consequences of sea level rise and severe weather to coastal development continued to be a predominant response as government, planning authorities, the financial sector and developers struggle to understand the complexities and uncertainties of the science related to this emerging coastal risk. Local governments, which can bear the largest responsibility for coastal planning, struggle to balance continuing strong demand for development along the shore with protection of fragile habitats and important social norms and cultural assets (Georgetown Climate Center 2011). In an economic period characterized worldwide by diminishing revenues, governments must often weigh short-term benefits against long-term threats to infrastructure, ecosystems and community well-being.

The potential climate change impacts to coastal infrastructure, sensitive environments and local economies include (Belle and Bramwell 2005, Boateng 2008, Cartwright 2011, Field et al. 2001, GOV/USA/NOAA 2002, Nicholls et al. 2007, Simpson et al. 2008, Trotz 2002, UNEP 2009b):

- increased inundation (flooding) of coastal lands, with potential loss of life and damage to or loss of homes;
- inundation, destruction and loss of infrastructure (i.e. power, roads, bridges, water and wastewater systems, communication networks);
- backups caused where drainage largely relies on gravity (sea level rise will slow the flows of both natural overland and riverine drainage and the flow of water through storm water, sewage and other effluent pipes and outfalls);
- potential increased chemical and biological contamination of surface and groundwater, as well as coastal waters as a result of overflows from and damages to collection, treatment

> "Today, rising sea levels are submerging low lying lands, eroding beaches, converting wetlands to open water, exacerbating coastal flooding, and increasing the salinity of estuaries and freshwater aquifers. Other impacts of climate change, coastal development, and natural coastal processes also contribute to these impacts. In undeveloped or less-developed coastal areas where human influence is minimal, ecosystems and geological systems can sometimes shift upward and landward with the rising water levels. Coastal development, including buildings, roads, and other infrastructure, are less mobile and more vulnerable. Vulnerability to an accelerating rate of sea level rise is compounded by the high population density along the coast, the possibility of other effects of climate change, and the susceptibility of coastal regions to storms and environmental stressors, such as drought or invasive species" *(GOV/USA/EPA 2009).*

and disposal systems, and leaching from solid waste facilities, tailings ponds and other industrial and municipal waste treatment systems;

- increased salinity in estuarine and aquifer water, affecting ground and surface water sources of drinking and irrigation water;
- damage and destruction of tourism infrastructure, port and other beach front properties;
- impacts to ports, harbours and marinas, including higher maintenance costs and increased dredging;
- combined flooding of low-lying areas faced with increased levels of storm run-off and higher storm surges;
- increased property damage and loss from hurricane activity and other severe weather events;
- increased costs for implementation of shoreline protection measures;
- increased costs and reduced availability of insurance coverage for property;
- dislocation of coastal populations from homes and traditional use areas;
- increased demand and competition for coastal lands as a result of land lost to sea level rise;
- altered coastal aesthetics and reduced beach quality that affect the distribution of tourism demand and subsequent changes to local employment structure;
- reduction and loss of coral reef systems due to bleaching caused by higher sea surface temperatures; and increased sedimentation from coastal erosion and runoff;
- reduction and loss of mangroves and other wetland ecosystems as a result of changing water levels, erosion and sedimentation and higher salinities, and ;
- changes to local erosion and sedimentation processes leading to instability of coastal banks and cliffs, and to the reduction and loss of beaches and dune complexes; and
- vulnerability of most of the above to reactive, sometimes maladaptive, measures that may contribute short-term relief but result in longer term damage to the systems they were intended to protect.

According to Boateng (2008) the extent to which sea level rise and severe weather will impact coasts and coastal communities may be affected by local factors, such as:

- coastal geomorphology and the level of exposure (e.g. delta, beach, marsh, estuary, cliff);

- geology (e.g. erodible soils, rocky outcrops);
- intensity of existing development;
- historic loss of protective coastal features (e.g. marshes, mangroves);
- capacity and affordability of coastal defence measures as an effective long-term protection option;
- natural adaptive capacity of the affected coast;
- pre-emptive planning for adaptation planning and mitigation; and
- availability of alternative and affordable sources of goods and services during storm events.

Nowhere are the impacts to communities and to ecosystems more imminent and more important than in the low lying coastal areas of small island states and developing nations (IPCC 2007a, UNDP 2010) (Table 1). Coastal tourism, which can be highly vulnerable to climate change is an increasingly important component of national and local economies. In a study of 906 coastal tourism resorts in 19 CARICOM countries, Scott et al. (2012a) reported that if sea levels rise one metre from current conditions, 266 (29%) would be at risk of partial or full inundation. Potential inundation risks were not uniform across all countries, and in five countries, more than 50% of the coastal resorts could be affected. Between 49-60% of coastal resort properties located on unconsolidated beaches were determined to be at risk from associated increases in coastal erosion.

Table 1: Estimated annual economic impacts of climate change on CARICOM countries circa 2080 (adapted from CCCCC 2009, p10)

SEVERE WEATHER AFFECT	ECONOMIC IMPACTS (IN CONSTANT 2007 US$ MILLIONS)
Total GDP loss due to climate change-related disasters	**$ 4,936.9**
Tourist expenditures	$ 447.0
Employment loss	$ 58.1
Government loss due to hurricane	$ 81.3
Flood damage	$ 363.2
Agricultural damage due to flood	$ 1.7
Drought damage	$ 3.8
Agricultural damage due to drought	$ 0.5
Wind storm damage	$ 2,612.2
Agricultural damage related to wind	$ 1.9
Loss of labour productivity (GDP/capita) due to increased hurricane-related disasters (e.g., wind storms, floods, and landslides)	$ 0.1
Flood disability-adjusted life year “DALY” (GDP/capita)	$ 0.8
SEA LEVEL RISE	

SEVERE WEATHER AFFECT	ECONOMIC IMPACTS (IN CONSTANT 2007 US$ MILLIONS)
Loss of land	$ 20.2
Hotel room replacement costs	$ 46.1
Housing replacement costs	$ 567.0
Electricity infrastructure loss	$ 33.1
Telephone line infrastructure loss investment needs	$ 3.9
Water connection infrastructure loss investment needs	$ 6.7
Sanitation connection infrastructure loss investment needs	$ 9.0
Road infrastructure loss investment needs	$ 76.1
Rail infrastructure loss investment needs	$ 2.7

In recent years, policy makers throughout the Caribbean and in other vulnerable coastal areas have steadfastly identified the need to manage existing properties and infrastructure and to site and to design new facilities that are less vulnerable to coastal inundation and that are more resistant to hurricane damage (CARICOM 2003, CCCCC 2009, EU 1995, GOV/AUSTRAL/WA 2012, GOV/USA/NOAA 2012a, 2012c). In dealing with these and other impacts of climate change, the options available to coastal managers can be summarized as (McCulloch et al. 2002, p23):

- ***prevent*** the loss:
  - adopt planning and design measures that will reduce vulnerability;
  - change the affected activity: stop doing things that are impacted by the changes in climate;
  - change the location of the activity: move to a less vulnerable location;
- ***tolerate the loss:*** do not reduce vulnerability, and absorb the cost of the losses as they occur; or
- ***spread or share the loss***: do not reduce vulnerability, but spread the burden of the losses with investors, with taxpayers through the provision of government reparation for damages, or through insurance.

The reality is that in many nations, without either adequate legislation, resources and/or political will, private development interests- large or small – have built right down to the beach, infilled or bulldozed vegetation, drained and filled wetlands, and used the ocean as a repository for waste (Barange et al. 2010, GESAMP 2001a, 2001b, MEA 2005, Miles 2009, NRC 2004, Peterson et al. 2011, Steffen et al. 2004, UNEP 2007, 2008b, UNEP/CEC/IISD/WRI 2002, UNU-INWEH 2008, Whittle et al. 2002). Proactive planning controls on development are one of the few measures that have had positive short- and long-term benefits to communities and to environments, at limited or no cost to governments.

Coastal setbacks are one of the tools planners can use to advance proactive planning, prevent impacts to coasts and coastal people, and reduce the long-term liabilities to environments and communities. Because coastal setbacks have a varied range of applications and benefits, there is increasing interest in their application as a national, regional and local land planning and development management tool (Cambers and Roberts-Hodge 2013, GOV/AUSTRAL/WA 2006, GOV/USA/NOAA 2012c). Setbacks are anticipated to become an even more salient strategy as coastal management authorities prepare for the risks and hazards of climate change and sea level rise.

While there are a number of recent examples of the inclusion of coastal setbacks in coastal management policy at the national and state/province level (e.g. United States, Australia, New Zealand, Canada, Anguilla, St. Kitts, Nevis – see discussion in Section 4), to date only one Regional Sea - the Mediterranean – has adopted a multilateral policy framework. Under the *Protocol on Integrated Coastal Zone Management in the Mediterranean,* signatory nations of the Barcelona Convention are required to implement a minimum 100 metre coastal development setback (EU 1995). Despite this multilateral progress, the ongoing governance challenge to these and other nations is to ensure that coastal setbacks become an integral feature of local land use planning and development management through the development and application of the necessary rules and regulations for effective implementation and enforcement.

3.0 Setting the Groundwork for a Shared Understanding: Key Terms and Concepts

One of the difficulties inherent in any discussion that bridges academic and professional disciplines, economic sectors, levels of government and countries can be the miasma created when terms (e.g. coast, ecosystem health, sustainability, climate change) are interpreted with confidence by individuals and groups that have widely ranging perspectives on meaning and application. The following section provides definitions for some key terms used in the planning and management of coasts, and in dealing with the evolving challenges of climate change.

Definitions and explanations are derived whole or in part from the documents referenced. Additional definitions of relevant terms are included in Appendix A.

Coast

As defined by Mercer Clarke (2010) in Figure 1, a coast is a distinctive cluster of linked, or nested, terrestrial, aquatic and/or marine ecosystems, that may occur geographically from the headwaters of watersheds to the outer limits of the offshore coastal waters; that includes unique ecotones, or transition systems between the land and the water; and that supports co-dependent human communities who are responsible for both the exploitation and sustainability of coastal resources and ecosystems.

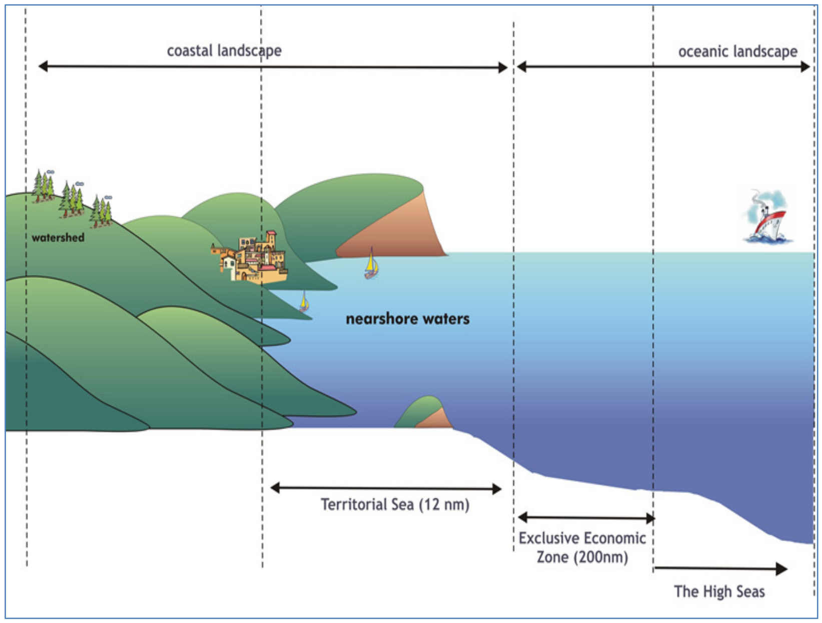

Figure 1: The coastal landscape as proposed by Mercer Clarke (2011, p30).

Other definitions for coastal zones or coastal areas often respond to jurisdictional boundaries, and can serve to exclude rather than to include responsibilities for integrated oversight, planning and management of coastal systems.

Coastal Management

Coastal management has been described as a continuous and dynamic process by which decisions are made for the sustainable use, development and protection of coastal and marine areas and resources. Coastal management aspires to the sustainable development of lands and resources, to reduced vulnerability of coastal ecosystems and their inhabitants to natural hazards, and to the maintenance of ecological processes, biological diversity, ecological services and human well-being (Cicin-Sain and Belfiore 2005, Mercer Clarke 2010).

Benchmarks

In general use a benchmark is a reference point or standard against which performance or achievements can be compared. Along the shoreline benchmarks often describe the average height of water as assessed over a defined time frame (e.g. 75 years), and describe conditions such as mean high water, mean tide levels, mean low water. Mean sea level (or mean tide level) is generally defined as the average relative sea level over a defined period (e.g. a month, a year), calculated from sufficient data on observed conditions to average out transient events such as storm waves and higher than usual tides.

Seaward benchmarks are used to establish reference points for assessing past changes and/or projecting future changes in aspects of coastal dynamics such as beach conditions, dune stability, vegetation limits, storm surge inundation, sea level rise, and coastal erosion.

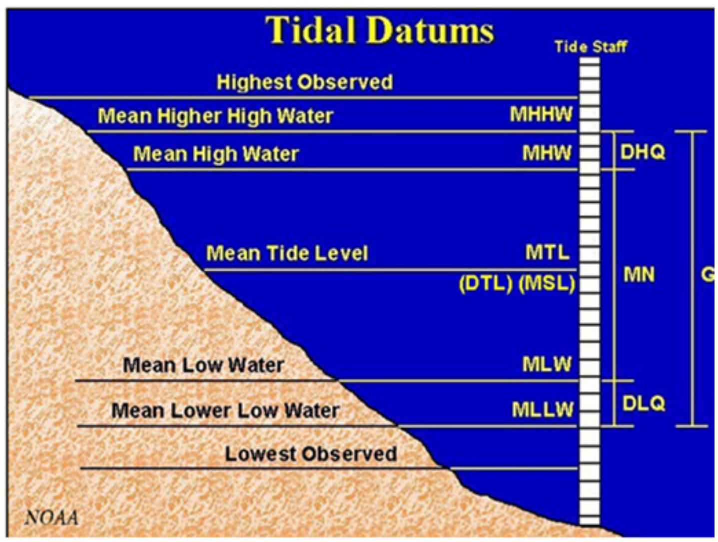

Figure 2: Tidal datums (GOV/USA/NOAA 2012d)

Local Sea Level

Local sea level refers to the height of the water as measured along the coast relative to a specific point on land. Mean sea level is determined by measuring the change in elevation of the water's surface as compared to a benchmark, and averaged over a prescribed time period (i.e. one month, one year).

Benchmarks are generally established as land-fixed horizontal and vertical control points (or datums – see Figure 2), that allow for the changes in sea level to be measured relevant to these permanently attached reference points. It is important to note that while tidal benchmarks are generally the basis for marine bathymetry and water level changes, they are not the basis for mapping of land topography. As a consequence, reconciliation of topographic mapping and marine charts is often necessary to ensure accurate representation of the predicted effects of sea level changes.

Sea Level Rise

Sea level rise refers to local and/or global changes in mean sea level over time as a result of thermal expansion of the ocean, the increased melting of land-based ice and changes in local tectonics that result in changes in the shape of ocean basins (Higgins 2008, IOC 2009, IPCC 2007b).

Storm Surge

Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Storm surge should not be confused with storm tide, which is defined as the water level rise due to the combination of storm surge and the astronomical tide (Figure 3). This rise in water level can cause extreme flooding in coastal areas particularly when storm surge coincides with normal high tide, resulting in storm tides reaching up to 20 feet (6m) or more in some cases (GOV/USA/NOAA 2012a). The storm surge is defined as being the excess above the level expected from the tidal variation alone at that time and place (IPCC 2007a).

Storm surges driven by hurricane force winds and changes in barometric pressures can exert significant changes in local high water levels.

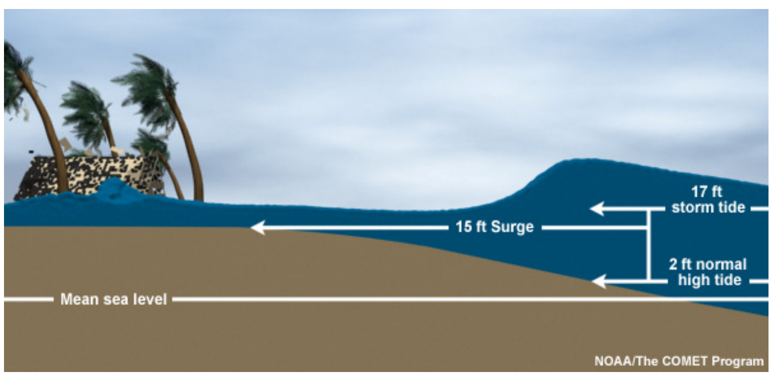

Figure 3: Storm surge as compared to storm tide (Downloaded from NOAA (GOV/USA/NOAA 2012b))

Inundation

The state of flooding of coastal land resulting from the impact of a flooding, usually measured perpendicularly to the shoreline (IOC 2009).

Sand Dunes

Dunes are highly dynamic topographic features of coastal landscape, and especially when not anchored by vegetation, may undergo rapid changes over short time periods. Sand dunes are highly mobile land forms that can rapidly move or disappear altogether. Dunes can move inland as a result of onshore winds and can be eroded by wave action and storm surges. Loss of dune vegetation as a result of drought, disease, animal-grazing or other human use, including pathways, can result in localized blowouts in dune structure (UNEP/CEP 1998). In coastal areas, dunes often function as a protective barrier diminishing the impact of storm waves and preventing water from reaching the land behind the dunes. Dunes also serve as a reserve for beach sand that has been eroded away by storm events.

Climate Change

Climate change refers to a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer (IPCC 2012). Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC 2007a). The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. The UNFCCC makes a distinction between climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes (IPCC 2007a).

Abrupt Climate Change

The IPCC has suggested that the major risks to society and environment from climate change may be primarily posed by abrupt and extreme climate phenomena rather than by the continual warming trend. Abrupt climate changes could include sudden melting of glaciers and/or widespread melting of permafrost leading to large scale shifts in the carbon cycle (IPCC 2007b). Abrupt and extreme phenomena take place relatively rapidly and unexpectedly, compromising the adaptive capacity of human and natural systems. Abrupt changes in climate are most likely to be significant, from a human perspective, if they persist over years or longer, are larger than typical climate variability, and affect sub-continental or larger regions (IPCC 2007a, 2007b, NRC 2002).

Coastal Hazards

A hazard is a potentially damaging physical event or phenomenon that may cause loss of life or injury, property damage, social and economic disruption or environmental degradation. A hazard is characterized by its location, intensity, frequency and probability (UN/ISDR, 2004b). Coastal hazards are physical hazards whose impacts threaten the well-being of coastal environments and human populations. Coastal hazards generally fall into two main types: those with rapid onset (e.g. tsunamis, storm surges and extreme wind-forced waves) and those which occur cumulatively or progressively over a long period of time (e.g. sea level rise, coastal erosion) (IOC 2009). The impacts of coastal hazards are increasing, probably as a result of growing human populations in coastal areas, changes in coastal land use, human degradation of natural coastal protection features and changes in riverine flows. As sea levels rise, the hazards posed by storm surges, coastal erosion and riverine flooding also increase. A creeping (or slow onset) hazard is one that impacts progressively over the long term, such as sea level rise.

Adaptation

Adaptation to climate change refers to the adjustments to natural or human systems that are made as a response to actual or anticipated changes in the environment or the effects of those changes. The form taken by these adjustments can moderate the harm caused by climate change, or it can exploit new and beneficial opportunities that arise as a result of the changes (IPCC 2007a, 2012, Parry et al. 2007).

Managed Realignment

Managed realignment is the process by which armoured, dyked, and/or infilled shorelines are returned to what is estimated to be a more natural condition (Figure 4). Managed realignment assumes that while natural shorelines are relatively stable, over

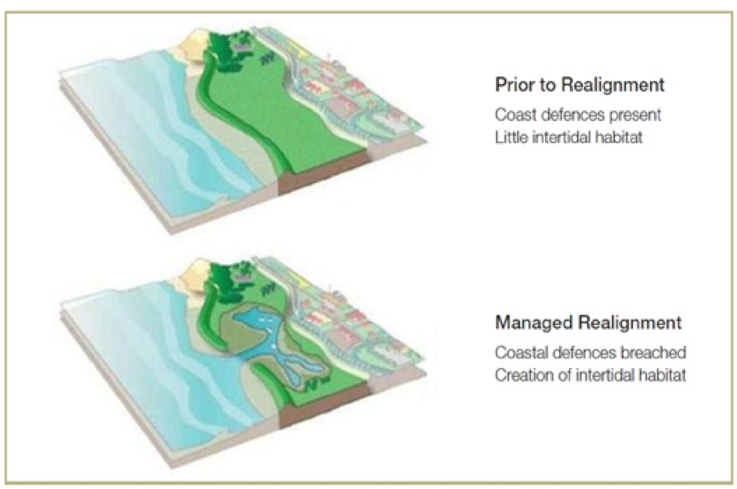

Figure 4: Managed realignment (ClimateTechWiki 2012)

the centuries that stability has been interfered with and dramatically changed by storm events and by human construction and use. Most managed realignment initiatives focus on the removal or landwards relocation of the line of coastal defence measures (e.g. dykes, armoured sea walls) so as to return in-filled land to the sea, to allow for the return of natural beach erosion and sedimentation processes and to allow coastal vegetation (e.g. mangroves, marshes) and/or intertidal mudflats to develop (ClimateTechWiki 2012, French 2006, Friess et al. 2008).

Land Use and Land-Use Change

Land use refers to the total of arrangements, activities and inputs undertaken in a certain land cover type (a set of human actions). The term land use is also used in the sense of the social and economic purposes for which land is managed (e.g. grazing, timber extraction and conservation). Land-use change refers to a change in the use or management of land by humans, which may lead to a change in land cover (IPCC 2007a).

Sustainable Development

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland 1987).

Ecosystem Services

Ecosystem services are benefits to humans provided by combinations of ecological, physical, and chemical processes taking place within managed and natural ecosystems (Thrush and Dayton 2010). Ecosystem services represent a broadening of the valuation of ecological systems by society, including a growing catalogue of benefits that can range from easily quantifiable goods such as food, to more intrinsic and less tangible values. Ecosystem services have been categorized as provisioning services (ecosystem goods directly harvested or used by human society); supporting services (fundamental processes that control the structure and functioning of ecosystems); regulating services (functions such as climate regulation, water purification, and waste treatment of value to human society as well as to ecosystem integrity); and cultural services (non-material benefits, e.g. spiritual, aesthetic, heritage, education, recreation) that are important to the well-being of human society and to individuals (Costanza 2010, Thrush and Dayton 2010, Zaccarelli et al. 2010).

Ecosystem Approaches to Management

The Convention on Biological Diversity (UNEP/CBD 2004) defines an ecosystem approach to management as a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Ecosystem approaches to management (EAM) encompass an array of emerging perspectives and frameworks based on a more holistic context for management of environments and resources. EAM draws on science advice on the structure, processes, functions and interactions among organisms and their environment, recognizing that humans are an integral part of the ecosystem (Thrush and Dayton 2010).

Vulnerability

The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards (UN/ISDR 2004b).

Resilience

The capacity of a system, community or society potentially exposed to hazards to adapt by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures (IPCC 2012, UN/ISDR 2004b).

Uncertainty

An expression of the degree to which a value (e.g. the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. In discussions on the certainty of climate change and its impacts to coastal systems, the probability of events occurring as predicted often comes into question. It is important that in discussions on uncertainty, there is a shared understanding of the likelihood of events happening as predicted, as is expressed by Figure 5.

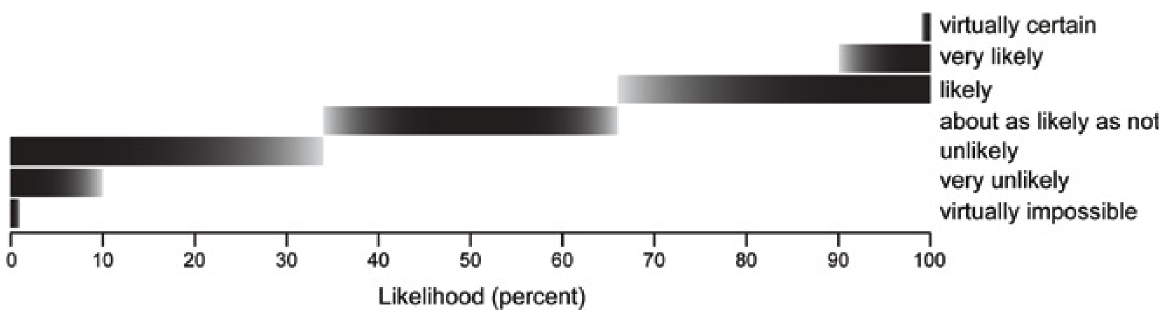

Figure 5: Likelihood terms and related probabilities as expressed by the USA Environmental Protection Agency (GOV/USA/EPA 2009, pxv)

Risk

The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between hazards and vulnerable conditions. Conventionally, risk is expressed by the notation *Risk = Hazards x Vulnerability.* (UN/ ISDR, 2004b).

A combination of the vulnerability of the system and the intensity of the pressure (stressor) on, a system - a highly vulnerable system exposed to a high level of pressure is considered at high risk.

4.0 A Review of Current Setbacks Practice

This section provides a brief summary of available information on current practice on the development, implementation and evaluation of coastal setbacks organized by region, and then by country (selected) in the LAC region (Sections 4.1 and 4.2). The review is based on documentation in the scientific literature and in the grey literature (reports and papers by government and non-government organizations) as well as communications with relevant experts. Significant bodies of literature on setbacks exist for Europe, Australia and for the United States. Within these regions, sub-national coastal governance can vary substantially. Examples of the diverse policies and approaches are presented in the following sections.

Less information is available for other countries. What is available is fragmented by jurisdiction, and can be limited to policy statements of *intent* to develop setbacks for coastal development. Appendix C provides an international summary of setback regulations and information compiled during this study (by country or state/province).

4.1 Latin America and Caribbean Continental Nations

Within the continental countries of the Latin America and Caribbean Region information on coastal management is very limited, with only rare references to the use of coastal setbacks. No information on coastal setbacks could be identified for Argentina, El Salvador, Guatemala, Guyana, Honduras, Peru or Suriname. Bolivia and Paraguay are landlocked and not included in this study. Somewhat dated references to coastal setbacks were identified in Clark (1992) and in Lemay (1998). These are summarized in Table 2.

Table 2: Coastal setback distances in selected Latin American countries (Clark, 1992, Lemay, 1998)

Country	Setback Distance (m)
Chile	80
Columbia	50
Dominican Republic	60
Ecuador	8 m plus a greenbelt for mangroves
Mexico	20
Panama	20

More recent information on coastal setback policies in other Latin American countries is reviewed in the following sections (4.1.1 to 4.1.6) and a summary table of setbacks in the region is available in Appendix C.

4.1.1 Belize

The most current setback legislation for Belize was written into the National Lands Act of 2000, where any development outside of a city, town or village that adjoins any running river, stream, or open water is required to leave a 66 feet (20m) wide strip of land in its natural state, unless the Minister approves otherwise (GOV/BELIZE 2000a). This setback is measured from the high water mark experienced during ordinary tides (GOV/BELIZE 2000a). There has been some debate over the setback distance which dates back to the original Crown Lands act of 1886, and the use of an historic surveying measurement where "one chain", was sixty six feet long (GOV/BELIZE 2000b). As the current law is based on century-old survey legislation rather than modern research, there is no specific intent to protect the coastlines or nearby development. This can become an issue in coastal development planning, as the Minister can permit exceptions to the law, especially since there are no clear goals or mandates in place as to whether or how those exceptions should be granted (GOV/BELIZE 2000b). Within Belize, mangrove forests are specifically protected under the Forest Act, and the combination of this statute and the National Lands Act effectively creates a 66-foot wide buffer along the coast for existing mangrove forests. Even if one exception is granted for cutting down the mangroves, a second exception is required to continue such destruction into the sixty six feet of the coastal buffer zone (GOV/BELIZE 2000b). There have, however, been problems in implementation, largely related to issues over leased land, and the lack of knowledge of, and therefore compliance with, the law (GOV/BELIZE 2000b).

4.1.2 Brazil

Brazil's National Coastal Management Plan (Law 7661) of 1988 passed responsibility for coastal zoning to the states, while both the federal and state governments remain responsible for monitoring coastal areas for environmental abuses (Jablonski and Filet 2008, Muñoz 2001). In Brazil the coastal zone has been described as a *geographic space of interaction of air, sea and land, including its renewable and non-renewable resources* that extends seaward up to 12 nautical miles (Muñoz, 2001). While the Brazilian Coastal Management Plan addressed changes in maritime law and provided responses to some environmental protection concerns, it was comprised of somewhat general statements that lacked clear directions in some areas (Muñoz 2001). The Plan also ran into difficulties effecting management of coastal areas that are under increasing pressure from human activity (Muñoz 2001). It was not until 2004 (Decree 5300) that enabling legislation for the Plan added information and enforcement tools, such as the Federal Coastal Zone Plan of Action, the State and Municipal Coastal Management Plans Information System, an Environmental Monitoring System, an Environmental Quality Report and Ecologic-Economic Coastal Zoning. The *coastline* was also defined as a marine strip (up to 10m depth) and a terrestrial strip that ranges from 50m in urban areas to 200m in non-urban areas, as measured either from the tidal line or from the inland boundary of the existent ecosystem (Jablonski and Filet 2008). In defining coasts this way, Brazil included estuarine counties and municipalities that faced the shoreline (also capturing non-littoral municipalities that were contiguous with large coastal cities but could be as much as 50 km from the shoreline). Beaches are designated as public property and are required to have free public access (Jablonski and Filet 2008).

In addition to the Plan and the Decree, there is also a National Policy for Sea Resources (1980), a National Policy on Coastal Management 1997, and State and Municipal Plans for Coastal Management that impact on coastal decisions (Seraval 2010, Seraval and Alves 2011). Under these instruments, states and municipal districts are permitted to create legal instruments in their respective State and Municipal Plans of Coastal Management (Szlafsztein and Sterr 2007). Some additional direction is provided in the form of non-binding resolutions, such as Resolution 303, which defines areas of permanent preservation such as natural lagoons, mangroves, dunes and beaches, as well as areas for reproduction of wild fauna. Outside of these controls, no documented legal coastal setbacks were identified, although Lemay (1998) reported a coastal setback of 33m for Brazil.

It appears that the legal framework and the theoretical basis to support coastal management in Brazil are in place but effective implementation can be lacking in many cases (Muñoz 2001, Seraval and Alves 2011). The institutional framework needed to implement coastal management remains limited and there can be marked differences among states in the manner in which the national policies and legislation are implemented (Jablonski and Filet 2008, Munoz 2001).

Further, state and municipal decisions, as is the case in other countries, can be strongly influenced by economic interests (Jablonski and Filet 2008).

4.1.3 Costa Rica

In 1884, Law 8 was passed in Costa Rica designating the area from the low tide line to one nautical mile inland as a public domain (with the exception of a few large historic Spanish land grants). In 1970, Law 4558 established a 200m coastal zone of public ownership for all lands falling outside the Spanish land grants, or contained within the six coastal cities (Sorensen 1990). The Costa Rican government was concerned with both the degradation of the coastal zone as a result of unplanned development (e.g. residential and tourism), and the increasing need to protect their beaches, which have significant potential to generate income from tourism development (Sorensen 1990). As a consequence, Costa Rica enacted Law 6043 and associated regulations on The Planning and Management of the Marine and Terrestrial Zone in 1997). The law establishes a maritime/terrestrial restricted zone which is owned by the national government and administered by the municipalities (Cordero and Bonilla 2006, Sorensen 1990). The restricted zone consists of a 50m wide Public Zone, measured inland from the high tide mark, or from the inland limit of coastal wetlands (primarily mangroves), as well as a 150m wide Restricted Zone measured landward from the Public Zone (Cordero and Bonilla 2006, Lemay 1998, Sorensen 1990). Although the Public Zone is open to the public and development is generally illegal, the public cannot gain access through the Restricted Zone, or as the result of trespass across privately owned property. Areas of the Restricted Zone may be leased for use for a term from 5 to 20 years. These concessions are largely assigned to personal homes or tourism developments, on the condition that ownership of any structures revert to the municipality at the end of the lease, unless the lease is granted renewal (Cordero and Bonilla 2006, Sorensen 1990).

The original text of Law 6043 has been revised with eight amendments. A number of other regulations, over 50 Attorney General's Office opinions, Constitutional Court rulings, and Comptroller General directives cover the Marine and Terrestrial Zone. The National Coastal Development Plan, a requirement of Law 6043, was developed in 2003 and updated in 2006 (Cabrera 2008). Costa Rica has added other legal instruments for the management of coastal areas, such as the 2008 Chorotega Decree No. 34456 which provides more detailed direction for planning and beach protection in the Chorotega Region, extending its authorities up to three kilometres inland (Cabrera 2008).

Despite the legal base and the intent, implementation of development controls can still be difficult. Developments have been approved in problematic areas such as high slopes, and without necessary water and sewer infrastructure, for example (Esquivel 2011). Costa Rican municipalities have responsibility for the design and approval of land use plans, for issuing building permits, for inspecting construction sites for adherence to permits, and for the prevention and enforcement of non-conforming activities. Communities can be both financially ill-equipped for this role and lacking in technical capacity (Cabrera 2008). As well, it has been reported that the decisions made under the national process for approvals, as administered by the Costa Rican Tourism Board, are not well integrated with local governance and may not be respected by the local municipality (Cordero and Bonilla 2006, Esquivel 2011). Coastal land use plans, where they exist, are not coordinated with neighbouring areas, and conflicts over decisions, including legal complaints, may not receive appropriate or timely attention from local institutions (Cabrera 2008; Sorensen 1990).

4.1.4 Nicaragua

In the past 100 years, Nicaragua has adopted multiple property laws that can be both complex and contradictory. The government has taken recent steps to simplify these laws to preserve public access to the beaches and protect marine life from the hazards associated with property developments. Nicaragua's setbacks have been established as part of Law 690: the Law For Development of Coastal Areas, which defines a 150 foot (48m) setback from the high tide mark (GOV/NICAR 2009). This zone is established for public use, with no construction or development allowed. Prohibited activities include: residential buildings, the construction of roads, the installation of overhead high voltage power lines, the permanent installation of commercial advertising, and motor vehicle traffic or parking on popular resort beaches. Developers of tourism facilities must also provide a 10m public access easement on any new development. Existing developments are not affected. There is an additional 200m setback from the 48m public use zone where limited development is allowed, but buildings are restricted to tourist services, residential homes, or berths for marine tourism (GOV/NICAR 2009).

4.1.5 Uruguay

In the Water Act of 1978, Uruguay established legislation that mandates a 250 meter setback from the high water mark, determining the latter as the average of the highest peaks recorded each year over a period of at least 20 years (GOV/UAR 2009). In addition to the formal setback, there is a tradition of installing a coastal boulevard on the seaward side of developments, which in practice has added a further 100 to 200m setback. Although these setbacks were not related to erosion or sea level rise, they now act as protective measures and accommodations for both current and future coastal hazards.

Environmental issues became a higher priority for the Uruguayan government in the 1990s, when it created the Ministry of Housing, Land management and Environment, the National Environment Directorate and the Climate Change Unit. The Environmental Impact Assessment Law and the General Environmental Protection Act of 2000 (which specifically addresses climate change), have resulted in the preparation of plans and guidelines for coastal management, land planning and tourism development. In some areas, illegal structures in the setback zone have been removed (Agrawala et al. 2004). Poor coordination among government authorities and other stakeholders, and difficulties encountered in engaging the private sector in coastal zone protection can challenge the enforcement and management of setback policies (Agrawala et al. 2004). The difficulty in engaging the private sector may in some part be due to the size of the 250m setback, which is significantly larger than other nations have determined to be necessary for protecting their coastlines, but for which Uruguay has not provided a defensible logic.

4.1.6 Venezuela

In Venezuela, the Law of Coastal Zones (2001) defines the coastal zone and provides for the development of a National Plan for Integrated Coastal Zone Management. Under the Law, 88 Coastal Units have been identified, together with a number of management programs and national policies, directives and guidelines focussed on the conservation and sustainable development of each coastal unit (Castillo et al. 2011). No information specific to coastal setbacks was identified.

4.2 Caribbean Island Nations

Setback guidelines for island nations throughout the Caribbean are widely varied and relatively inconsistent. Among most of the nations, there can be wide agreement that coastal development carries risks due to erosion of the coastlines and storm surge events. Despite the increasing evidence of past and current economic damages attributed to severe weather events (Bueno et al. 2008, CCCCC 2009), this has not yet resulted in a consistent response to adaptation to existing or impending coastal hazards (CCCCC 2011).

In recent years, CARICOM nations have worked to advance implementation of a *Regional Framework for Achieving Development Resilient to Climate Change* (CCCCC 2009, 2011, 2012), in which one of the strategic goals is to encourage action that reduces the vulnerability of natural and human systems to the impacts of a changing climate. A key interest areas of participating nations is the early assessment of coastal vulnerabilities (CCCCC 2011).

In the past decade, Anguilla, Nevis, Antigua and Barbuda, and the Bahamas have each developed targeted coastal zone management plans as a response to detailed studies of beach conditions and requirements. The studies were funded by UNESCO and conducted by Cambers (1997, 1998b, 1998c) and Sealey and Flowers (2006) in the aftermath of Hurricane Luis (1995). Many of Cambers recommendations for the islands have been adopted, however it is important to note that these studies were specific to the islands under study, using location data for each beach and coastline to calculate appropriate setback distances and conditions. To be useful in application by other nations the methodology developed by Cambers would require application of a similar process of assessment and calculation based on data on local conditions, where it is available. This has not occurred over the last decade, though this would be a valuable contribution to capacity building in these countries by international development agencies.

A number of other Caribbean nations (i.e. Barbados and the Dominican Republic) have established setbacks for coastal development, but in practice there are enough exceptions under the law, or available means of appeal, that the setbacks have had little effect on new development (Cambers 2012-pers. comm, Roberts-Hodge 2000, Sealey and Flowers 2006). The approaches taken by these nations and others in the region are discussed below. Other nations, such as Jamaica, St. Lucia, and Trinidad and Tobago, have no setback requirements on new development, though Trinidad and Tobago are currently drafting legislation. Cuba stands as a somewhat unique example, in that it has a strong legislative coastal zone protection plan that is both relatively simple in application, but complex enough to allow for the varying needs of different types of coastline landscapes.

4.2.1 Anguilla

Anguilla established coastal setback guidelines in 2000, in large part as a response to the coastal damage caused by hurricanes Luis (1995) and Lenny (1999) (Roberts-Hodge 2000). According to a review conducted in response to the aftermath of Hurricane Luis (Cambers 1998a) these setbacks were designed with four distinct categories;

- cliffs, where the setback is 50-60 feet from the cliff edge;
- low rocky shores, where the setback is 75-100 feet from the line of vegetation;
- sandy cays, where construction is limited to piled, wooden structures; and
- sand and stone beaches, where beach bars and restaurants must be 25 feet back from the line of vegetation, and each beach assigned to one of four additional categories, with setbacks of 60-75 feet, 75-100 feet, 150 feet, and 300 feet from the vegetation line.

However in reality, developers often appeal decisions on setback requirements made by the Land Development Control Committee to the Executive Council who can overrule the guidelines, rendering the setback guidelines largely ineffectual (Roberts-Hodge 2000).

4.2.2 Antigua and Barbuda

The government of Antigua and Barbuda has concluded that the potential risks to local beaches from sea level rise are of great concern given that the beaches are the principal tourist attraction, they are ecologically fragile, they have already been subjected to stresses from development and other pressures. To complicate the situation further, most of the country's principal hotels lie within 100 metres of the high water mark (GOV/ANT/BAR 2009)

Antigua and Barbuda, through their Sustainable Island Resource Management Plan (SIRZMP) have formally adopted coastal setback guidelines that were proposed by Cambers (1998c) as a result of a UNESCO funded initiative on planning for coastline change. The guidelines as developed by Cambers proposed several different categories for beachfront setbacks, dividing beaches into one of four categories, with each category having a setback of 18, 30, 40, or 91 metres.

The variable beach setback values were calculated based on a thorough study of measured erosion rates, projected risk from hurricane events, and predicted sea level rise by 2030. In Antigua, each beach was evaluated separately, and in Barbuda, the coastline was divided into sections (Cambers 1998b). The setback guidance provides an exception for mangroves and wetlands which must be evaluated individually (GOV/ANT/BAR 2011). For all shoreline types, setback distances are measured from the line of permanent natural vegetation. The Sustainable Island Resource Management Plan also includes allowances for the mitigation of risk through a range of requirements for minimum floor elevations, developed for different parts of the coast, but enforced only where an adequate analysis of storm surge events has been conducted to estimate the risks and hazards posed to the development (GOV/ANT/BAR 2011).

Basing the proposed setbacks on highly localized and environmentally specific conditions carries both advantages and limitations. The values determined for Antigua and Barbuda cannot be easily extrapolated to other locales without conducting similarly thorough evaluations of the coastline in question. Field data needed in determine appropriate setback distances requires decades worth of observed conditions to determine erosion rates, data which may be difficult to collect, or which may not exist in other areas. One of the strengths of the Camber's approach is in the careful attention to detail at a scale that provides both a reasonable amount of protection for coastal areas and for coastal development, as well as needed protection from coastal hazards posed by ongoing erosion, sea level rise and severe weather. Where data exist, it is relatively simple to demonstrate the erosion risks for the coastline under study, the potential risks to development infrastructure and investment and the increased risk incurred by locating the development in proximity to the existing shoreline. As is the case for most coastal nations, these risks will be borne not only by the environment, but also by the public and the private sector if there is eventual loss of the development infrastructure and/or the attractiveness and security of its use due to the encroachment of the ocean over the coming decades (Cambers 1998a).

4.2.3 Bahamas

The Bahamas are in the process of developing an Integrated Coastal Zone Management Plan, based on recommendations from several studies including the work completed by Cambers (1997). The current guidelines propose four distinct categories for setback distances (Sealey and Flowers 2006):

- high energy beach and dunes, setback of 10 metres inland from the dune crest or high point;
- high energy rocky shores, 5 metres inland from the cliff crest;
- low energy beaches, 15 metres inland from the line of permanent vegetation; and
- low energy rocky shores, 15 metres inland from the line of permanent vegetation.

The Bahamas have been working to develop a more comprehensive integrated coastal zone management plan, but as yet do not have supporting legislation in place. The setbacks which are enacted are not adequately enforced (Sealey and Flowers 2006), and the distances proposed are smaller as compared to similar legislation in use elsewhere in the Caribbean.

4.2.4 Barbados

Barbados established the Coastal Zone Management Unit in 1996 to manage coastal resources and structures. Rather than handling development and planning separately, the Unit consults with the Town and Country Development Planning Office regarding coastal developments (GOV/BARB 2012). Legislatively, setback requirements for development are contained within the Coastal Zone Management Act, which is vested within the greater Town and Country Planning Act, which manages all planning and development nationwide (GOV/BARB 2012).

The Coastal Zone Management Act establishes coastal setbacks for the nation, establishing a general rule of a 30 metre setback from the high water mark for beachfront developments, and a 10 metre setback from the cliff edge for cliff top developments (GOV/BARB 2012). These general guidelines, however, also have situational exceptions; any unique landscape features may have additional setbacks set specifically, to protect those features, and locations with prior buildings may have the setback restrictions eased to allow expansion of existing facilities (GOV/BARB 2010, 2012). In addition to these setbacks, however, Barbados has also enacted separate legislation regarding soil erosion, in the Tree Preservation Act, and are also expressing concern over the effects of increased sedimentation caused due to construction, on coral reefs offshore from the development (Mycoo 2006).

4.2.5 Cuba

In Cuba, Coastal Zone Management is legislated under Decree Law 212, approved on August 8, 2000 (GOV/CUBA 2000). The framework adopted creates two distinct zones of protection that together form a single setback distance for building and development purposes. The first zone is the Coastal Zone, which was established to protect fragile and unique ecosystems, as well as to preserve social and cultural connections and access to the coastal region (Decree Law 212, Article 2). The second zone is the Zone of Protection, which is intended as a buffer zone protecting the Coastal Zone against the negative effects of human activities (Decree Law 212, Article 5.1). In practice, the effective coastal setback area for almost any development consists of a combination of the area contained within the Coastal Zone plus the area contained within the Zone of Protection buffer.

In addition to the two zones, the system also provides different setback distances depending on the coastal area under consideration, as Cuba has divided its Coastal Zones into the following six classifications based primarily on physical environment factors (Decree Law 212, Article 4):

a) rocky shores or low terraces, where the Coastal Zone boundary is established as the furthest inland border of the ridge of loose material cast ashore during storms, or in the absence of such as ridge, the boundary is measured as 20 metres inland from the seaward edge of the line of natural vegetation;
b) coastal cliffs, where the summit of the cliff is not washed over by the sea at high tide, where the Coastal Zone boundary is established as 20 metres inland from the cliff edge;
c) river mouths, where the Coastal Zone extends 300 metres inland in a straight line from the river mouth, and 60 metres inland longitudinally from the river banks as far inland as the effect of tidal action is present;
d) beaches, where ecosystem is composed of loose materials, the Coastal Zone boundary is established as the landward edge of the dune closest to the sea, or in the absence of dunes, 40 metres inland from the line of natural vegetation;
e) mangrove forests and swamps, where the boundary is set at the inland border of the swamp or forest in question; and
f) any additional Coastal Zones which, for artificial or natural reasons, do not fit within the above classifications, the Coastal Zone boundary is established at 20 metres inland from

the point where the waves of the biggest known storms have ever reached, or the high tide during the equinox, whichever is higher.

The Zone of Protection extends these boundaries an additional 20 metres inland in regions a), b), and c), and 40 metres inland for regions d), e), and f), measured from the inland boundary of those Coastal Zones.

This system allows the Cuban government the ability to not only protect critical coastal regions from development, but the dual zone implementation prevents encroachment on that protected region as well. Rather than using a more typical approach where a single setback line is defined by a seaward point, the Cuban approach dispenses with setbacks that are locally specific or setbacks that are predominantly based on historical erosion patterns (data which may not exist). However, because the rates of coastal erosion are not factored into the determination of the Coastal Zone, the only potential to address changes to the shoreline, especially climate change induced changes (i.e. sea level rise and severe weather) is through the migration of vegetation lines, or changes in recorded storm surge levels.

4.2.6 Jamaica

Coastal zone management in Jamaica has been inconsistent and fragmented, without a unifying central plan or program that legislates a cohesive mandate for coastal zone protection (UNEP/GPA 2003). Various aspects of coastal zone management, such as various types of pollution control or fisheries management, are all enacted under their separate departments, but there are no building setbacks mandated under the Town and Country Planning Department or elsewhere in Jamaica's legislation (UNEP/GPA 2003). This situation has been recognized by the Jamaican Cabinet, and work is being done by the National Council on Ocean and Coastal Zone Management to codify these disparate rules into a cohesive whole, but as yet there has been no legislation passed which includes setback guidelines for construction and development (UNEP/GPA 2003).

4.2.7 St. Lucia

St. Lucia does not have typical setback legislation in the same manner as many other Caribbean nations, in the sense of relatively recent laws established to protect building and development from changes to shorelines and/or to protect coastal ecosystems from harm by the same development or construction. However, there is long-standing legislation that creates similar development controls, albeit for different reasons. When St. Lucia was originally colonized by the French in 1705, a strip of land 57 meters wide, measured from the high water mark, was delineated as Crown Land, known as the *Cinquante Pas de la Reine* (the Queen's Fifty Paces) (Mycoo 2005). While this serves as some protection, there is no law against the government granting or selling the use of the land, and there is a great deal of pressure by tourism investors to gain access to these lands for development (Mycoo 2005). These setbacks, while having been in place for over 300 years, exist with no clear mandate for enforcement and maintenance for issues such as shoreline erosion or environmental impact.

4.2.8 Trinidad & Tobago

The government of Trinidad and Tobago has recognized the necessity of protecting their coastal environments, and is currently in the process of developing a National Coastal Zone Management Plan, with setback guidelines included for new coastal developments (GOV/TRIN 2010). According to information provided on the Government website (GOV/TRIN 2010), setback policy is still in development and details are neither established nor currently available. Mycoo (2002) reported that the Trinidad and Tobago planning agency requires development that falls within the coastal zone but outside a designated harbour to be in accordance with standards that establish a setback from the high water mark. Setback distances are determined with advice from the Drainage Division, and the Institute of Marine Affairs, but are site specific and follow no minimum standard.

4.3 Global Policy and Practice

The need to protect humans and their built environment from the damaging effects of sea level rise and storm surges has been recognised in coastal nations all over the world (BBRA 2011, GOV/UAR 2009, Mascarenhas 2002). Where there is policy and or legislation to apply coastal setbacks, there have been mixed success in implementation. This section reviews the current practice in coastal setbacks in a number of areas around the world where sufficient information was found to contribute to a broader understanding of established and emerging coastal setback practices. The review is based on documentation in the primary literature and in the grey literature (reports and papers by government and non-government organizations). The areas examined include a regional sea, as well as individual countries, states/provinces, and municipalities. Information on the development and potential implementation of coastal setbacks exists for parts of Europe, Australia and for the United States, but less information is available for other countries. A summary table of setback regulations by country / state is provided in Appendices C and D. In some jurisdictions, there are policy statements of *intent* to develop setbacks for coastal development but little or no information on actual implementation tools. Where information was available, successes and limitations of the implementation were identified.

4.3.1 Europe and the Mediterranean

A number of the individual countries in Europe and surrounding the Mediterranean Sea have had legislation or guidelines for coastal setbacks for a number of years (Bridge and Salman 2000, Markandya et al. 2008, Rochette and Billé 2010, Sanò et al. 2011, Sanò et al. 2008, Sanò et al. 2010b, Sanò et al. 2010c). In countries that have enacted a setback requirement for coastal development, the average setback distance is 100 m from their designated seaward benchmark (Sanò et al. 2011).

In recent years the European Union has put forward a number of policy and legal instruments intended to guide and/or require improved management of the coast by member states (i.e. Recommendation on ICZM (2002), Water Framework Directive (2000), Marine Strategy Directive (2007), Flood Risk Management Directive (2007), Inspire Directive (2007), and the European Landscape Convention) (Sanò et al. 2008, Sanò et al. 2010b). In 2008, most signatories to the *Barcelona Convention* (which included the EU member states: Spain, France, Italy, Croatia, Greece, Cyprus and Malta, and a number of other countries bordering the Mediterranean Sea), signed the *Protocol on Integrated Coastal Zone Management,* which entered into force in 2011. While the spirit and text of the Protocol aim to establish a common framework for coastal management, states remain sovereign with respect to implementation.

In addition to general provisions on coastal management and coastal environmental conservation, protection and restoration, Article 8 of the Protocol identifies a minimum 100m coastal setback within which, with few exceptions, no new construction would be allowed (Rochette and Billé 2010, Sanò et al. 2011). The setback does not affect existing structures. Development that is in the public interest is considered to be an exception to the Protocol. Given the broad and non-restrictive terms that have been used in the wording, the interpretation of public interest may take different forms in different nations. When coupled with the complexities inherent in local geography, issues and constraints, countries have considerable opportunities for interpretation (Rochette and Billé 2010).

As established in the Protocol, the 100m setback line is measured from the highest winter waterline (a benchmark that dates from Roman times), which led Sanò et al. (2011) to suggest that it could move landward as sea level rises. However there are no explicit requirements for nations to periodically review and update the setback seaward benchmarks and distances. The Protocol, and particularly Article 8, set out minimum requirements and common criteria by which each signatory state will design and implement its own legal instruments (Rochette and Billé 2010). Sanò et al.(2008, 2010b, 2010c) have suggested an analytical framework that states could use to develop their own setback requirements, in conformance with the provisions of the Protocol. The technical analysis includes consideration of physical, ecological and socio-economic factors such as:

- coastal geomorphology;
- elevation models;
- calculations of maximum water levels (50 year return period) that take into account storm surge, tidal elevations, run-up and sea level rise and changes in maritime climate;
- ecological and landscape values, buffers and corridors;
- cultural and human landscape values;
- public coastal uses;
- analysis of transit and accessibility issues;
- review of existing and proposed policy and legal and administrative instruments; and
- public involvement and discussion on the proposed setbacks.

The wording of the Protocol ***carries an obligation for signatory nations to demonstrate effective implementation***, and is not satisfied by intent and the application of best efforts that, as reported by Rochette and Billé (2010), can have little actual positive result. However, given the complexity of the legal and administrative systems inherent within each member state, and the morphological heterogeneity of the coasts around the Mediterranean, implementation of a commonly shared approach to development setbacks continues to be a challenge (Sanò et al. 2010a).

4.3.2 Australia

Australia does not have a national policy on coastal development setbacks. Within the country the state and territory governments are responsible for coastal land management policy and regulatory frameworks (including coastal setbacks) for managing risks associated with coastal climate change (Gibbs and Hill 2011). The key Australian Government policies that guide the actions of the states are the Framework for a National Cooperative Approach to Integrated Coastal Zone Management and the National Climate Change Adaptation Framework (GOV/AUSTRAL/NSW 2008a). Both policies accept that Australian coastal communities are vulnerable to sea level rise, that there are benefits to an integrated approach to coastal management, and that priorities for action should include a national assessment of coastal vulnerability and the identification of appropriate planning policies to address both the protection of the built environment and the conservation of coastal ecosystems (GOV/AUSTRAL/NSW 2008a).

The states of Queensland and New South Wales have legislation for coastal management, while Queensland Western Australia and South Australia make specific reference to coastal setbacks (Gibbs and Hill 2011). All states except the Northern Territory regulate land use in coastal risk areas through zoning.

4.3.2.1 State of Western Australia

The state of Western Australia has within its Coastal Zone Management Policy a framework for strategies and plans for coastal development (GOV/AUSTRAL/WA 2006). Western Australia has also developed State Planning Policies on Environment and Natural Resources (2002) and Coastal Planning (2003) that include the incorporation of climate change risks into coastal development planning (Gibbs and Hill 2011; GOV/AUSTRAL/WA 2006). The State Coastal Planning Policy (Gibbs and Hill 2011) is intended to guide the Western Area Planning Commission as it integrates and coordinates the activities of state agencies, as well as local governments, in respect of coastal planning and management. The Policy includes coastal foreshore reserves, which address conservation, management, public access and recreation, and physical process setbacks. The Policy is largely implemented through the development of regional and local planning schemes, and local decisions on development applications that ensure new development is located so as to avoid coastal hazards (Gibbs and Hill 2011, GOV/AUSTRAL/WA 2006). In 2010 a ***Position Statement*** was issued to update the Policy to require allowances for climate change (GOV/AUSTRAL/ONSLOW 2011).

The Western Area Planning Commission has also published draft detailed guidance for the application of the State Coastal Planning Policy (GOV/AUSTRAL/WA 2012). The Policy uses a 100 year time horizon and as a general guide proposes a total coastal setback in the order of 100m from the horizontal setback datum (which may vary with shore type). The Policy also includes the following recommended setback calculation methodology based on physical process factors (including potential sea level rise) for new coastal development (Gibbs and Hill 2011, GOV/AUSTRAL/ONSLOW 2011, GOV/AUSTRAL/WA 2006):

S1 (acute erosion (storms)) + S2 (historic erosion trend) + S3 (sea level change) = setback for physical processes

The calculated setback is applied in addition to the setback related to foreshore reserves and to other non-physical factors. Thus the required total setback can vary with each proposed development. Local governments or developers conduct the technical studies required in support of the calculation of the coastal setback (GOV/AUSTRAL/ONSLOW 2007, 2011). For example, the Town of Onslow used the calculation outlined above to identify three options for coastal setbacks to be applied along six defined areas of its beach:

- S1 was based on modelling the effects of a Category 5 Cyclone combined with mean high water springs and the modelling of beach changes under the storm influence. The setback distances ranged from 63m to 253m for the designated beach sections;
- S2 was insignificant, so a safety factor of 20m was applied;
- S3 was calculated using a 0.9m sea level rise and the Bruun Rule (see Section 5.5.1 this report). The setback distance was determined to be 90m. The total setback ranged from 30m (where a seawall exists) to 372m.

In other areas of the beach where new developments are proposed to infill between existing structures, the S1 values would be used as a minimum setback. As applied in other jurisdictions, these setbacks based on physical processes are applied in addition to any foreshore reserve that may already exist.

While the Western Australia Coastal Planning Policy has been a significant step in adapting to climate change and sea level rise, implementation presents difficulties for the local governments, as evidenced by a growing body of litigation related to local council decisions (Gibbs and Hill 2011, Tomlinson and Helman 2006). Where private land is negatively affected by a planning decision, the owner may apply for compensation (within certain legal restrictions related to the land having a public purpose). This has increased the pressure from local councils for a national approach to coastal climate change risks (Gibbs and Hill, 2011).

4.3.2.2 State of New South Wales

In Byron Shire, the Local Environmental Plan (1988) was developed to address issues associated with severe coastal erosion. The Plan laid out an immediate impact line, a 50-year erosion line and a 100-year erosion line to provide for orderly development and protection of and from coastal processes. Seaward of the immediate impact line, new developments not related to beachfront use were not permitted, all development had to be easily removable, and could not require piped services such as water. In the next two development zones that fell between the three setback lines, houses had to be re-locatable and would have to be moved by the owner should erosion encroach to within 50m of the structure. The approach taken by Byron Shire was proactive and laudable, but as the last 30 years have been the lowest level of storm activity in the 200-year record, there has been a growing sense of false security and complacency and a subsequent easing of building restrictions in the setback areas. By 2005, the Plan had still not been completed and was subject to legal disputes (Tomlinson and Helman 2006).

4.3.3 New Zealand

The New Zealand Resource Management Act (1991) (RMA) and its subsequent amendments are the principal legislative tool for coastal management in New Zealand. The Act's purpose is to promote the sustainable management of coastal resources and the mitigation of natural hazards such as erosion and storms (GOV/NZ 2008, Scouller 2010). The Act provides for a 66 foot (approx. 20m) reserve or setback, that has historically been known as the Queen's Chain (Scouller 2010). The RMA Energy and Climate Change Amendment Act (2004) introduced an additional requirement to consider the effects of climate change (GOV NZ 2008). The New

Zealand Coastal Policy Statement (1994, and draft update 2008), is the national policy framework that directs the implementation of the RMA by states and communities with respect to coastal environments, but the policy direction provided can be seen as somewhat vague (Scouller 2010).

Under the RMA, regional councils must develop district coastal management plans that provide direction to territorial authorities in their development of regional plans (GOV NZ 2008, Scouller 2010). Local communities prepare their coastal plans following the leadership provided in the regional and territorial plans. Setbacks may be included in these local plans, but they are not a requirement (Scouller 2010). The plans do suggest that new developments, including subdivisions, be located and designed to avoid the need for engineered protection works (New Zealand Coastal Policy Statement 1994, Policy 3.4.5)(Forsythe 2009), and in some local district plans, new buildings in coastal erosion hazard zones are required to be relocatable.

For example, in their coastal plan the Auckland Regional Council advocates setbacks based on criteria such as public access, landscape value or ecological value, and not on coastal hazards (as they are not in a high risk area). The Rodney District Council plan sets out restricted shoreline yards, where construction is to be avoided (i.e. setbacks) of 50m in rural areas and 23m in residential areas. Where construction is proposed, an erosion assessment is required. In the high-risk area of the Bay of Plenty, the Regional Plan identifies Areas Sensitive to Coastal Hazards, and in the proposed Tauranga City Plan, Coastal Hazard Erosion Plan Areas identify and map 50 year and 100 year erosion risk zones. Building restrictions applied in these zones include managed retreat provisions that no subdivision takes place unless an alternate building site, not in the zone, is identified and maintained as vacant for eventual relocation of the building (Scouller 2010).

4.3.4 Canada

At the federal level, Canada has taken a risk management approach to climate change through the development of a national framework for climate change adaptation, as outlined in its report, *From Impacts to Adaptation: Canada in a Changing Climate* (Norman 2009). Within the framework, sea level rise and coastal flooding are a major focus. However, there is little reporting on national implementation of adaptation activities, suggesting that provincial or local planning efforts remain the primary tool for delivery of the goals for sea level rise adaptation.

Where plans do exist, coastal setbacks and environmental impact assessment of development are among the suggested tools for implementation (Norman 2009). The mix of jurisdictions between the federal and provincial governments, considering both the marine and the terrestrial spheres, is one of the factors that have prevented Canada from developing an effective integrated coastal management process (Shaw 2001).

4.3.4.1 Province of British Columbia

On Canada's Pacific coast, the province of British Columbia has set out Guidelines for Management of Coastal Flood Hazard Land Use. The document provides guidelines for local government officials and land-use managers in implementing land-use management plans and making subdivision approval decisions for lands exposed to coastal flooding hazards and sea level rise, including areas behind sea dikes (GOC/BC 2008, 2011).

The Province has established a minimum setback for construction of 15 m, calculated from the future Estimated Natural Boundary of the sea at Year 2100. This Natural Boundary would, of course, change over time as sea level rises. Guidelines used to determine the evolving Natural Boundary include:

- the Designated Flood Level (DFL) is first determined as the sum of future sea level rise + maximum high tide (HHWLT) + storm surge during a designated storm, all referenced to year 2100;
- the Flood Construction Reference Plane (FCRP) is then the sum of the Designated Flood Level (DFL) + an estimated wave effect, defined as 50 per cent of the calculated wave run-up on the estimated future shoreline; and
- the Flood Construction Level is the Flood Construction Reference Plane (FCRP) + freeboard, which depends on the site and structure but is at least 0.6 m.

The Flood Construction Level is the Natural Boundary. This setback may be modified based on shoreline type (GOC/BC 2011).

The Guideline notes that further sea level rise will move the future Natural Boundary further inland, and will result in a building constructed in 2000 (A in Figure 6) becoming less protected from the sea as time moves on. Considering that the building is likely to reach its expected lifespan around 2100 (B in Figure 6), the owner will then be faced with a decision. As illustrated in the figure below, rebuilding on or after 2100 could involve relocating the structure or modifying it to accommodate flooding in the lower floors, all the while respecting the new 2200 flood construction line and setback (GOC/BC 2008, 2011).

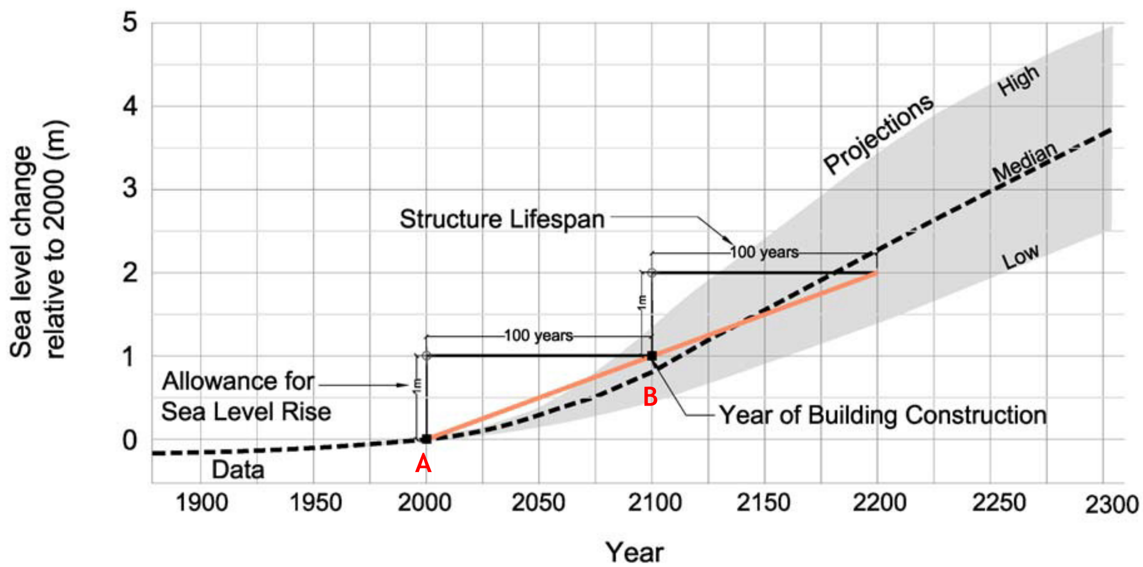

Figure 6: Incremental sea level rise effects on planning for structures within a 100 year projected life span (adapted from (GOC/BC 2011))

4.3.4.2 Province of New Brunswick

The Province of New Brunswick on Canada's Atlantic coast published a Coastal Areas Protection Policy in 2005 that would promote coastal management and adaptation at a local level (GOC/NB 2005, Norman 2009). The main objectives of the New Brunswick policy are to: maintain flora and fauna; minimise contamination; reduce threats to personal safety by storm surges; minimize public expenditures to repair storm damage; and protect coastal and inland areas from storm surges. The Policy sets out three sensitivity zones for coastal protection:

- Zone A - the areas closest to the water known as the coastal lands core area, marking the landward limit of features found between the Higher High Water Large Tide (HHWLT) and the Lower Low Water Large Tide (LLWLT) such as beaches and wetlands plus dunes extending beyond the HHWLT,
- Zone B - the areas 30 metres landward of Zone A which provide a further buffer, and
- Zone C - the areas beyond Zone B that form a transition from coastal to inland areas where development can occur (GOC/NB 2005, Norman 2009)

This zoning approach - core, buffer and transition - is the same conceptual approach used by the United Nations for the UNESCO (United Nations Educational, Scientific and Cultural Organization) Biosphere Reserves (GOV NB 2005).

Certain activities are deemed unacceptable in any zone, including groins; infilling; dredging, excavation and associated disposal activities without a federal permit; beach quarrying; and causeways where a bridge is a technically feasible alternative. Notwithstanding these, the Policy provides for environmental assessment of coastal developments.

Of the principles behind the Policy, two stand out. First, no government compensation would be provided to anyone who chose to build in hazardous areas (i.e. no transfer of the costs for private risk to the public purse), and no development should increase the risk for others. Second, public access to coastal areas would be secured.

The Policy, however, was published without a mechanism to review the criteria that define the sensitivity levels for the three zones, or a definition of the distance of Zone C (GOV NB 2005). This uncertainty led to a spate of development activity, some of it ill-considered, before the Policy actually came into effect.

4.3.4.3 Province of Nova Scotia, Halifax Regional Municipality

At the local level, the Halifax Regional Municipality (HRM) developed a Regional Municipal Planning Strategy (2006) that took a risk management approach to coastal issues, including sea level rise. The Strategy incorporated interim controls on development until a plan covering the potential hazards to development was completed. HRM uses a municipal land-use bylaw to require new residential development to occur at least 2.5m above the ordinary high water mark, with some exceptions for Halifax Harbour and Sheet Harbour (Norman 2009). For developers wishing to construct below the 2.5m line, the HRM provided a guide to assist them in specifically defining the risk to the site, and in evaluating options and proposing solutions for the management of the potential risk (Halifax Regional Municipality 2007).

The Guide is based on the Canadian Standards Association (CSA) publication *Risk Management: Guideline for Decision-Making (CAN/CSA-Q850-97),* wherein:

- the project is defined (and alternatives);
- hazards are analysed;

- risks are estimated (probability and severity);
- risks are evaluated; and
- adaptation and risk control are implemented.

The HRM Guide also contains a checklist for developments and buildings to provide more detailed direction to developers in meeting the bylaw requirements (Halifax Regional Municipality 2007).

Risk management has been broadly used in Canada to aid in responsible decision-making, and is coming into use in planning and management for climate change impacts. As a concept, *risk management* appears to more readily understood by the private sector than *adaptation* (Noble et al. 2005).

The Canadian Standards Association Risk Management Guideline has also been used in the development of a comparable Caribbean Risk Management Guideline (CARICOM 2003).

4.3.5 United States of America

In the United States, there is no national requirement for coastal development setbacks. The National Oceanic and Atmospheric Administration (NOAA) and the Environmental Protection Agency (EPA) are the main national agencies charged with addressing sea level rise and its impacts on US coastlines (Norman 2009). The Coastal Zone Management Act (1972) which is administered by NOAA sets out the national framework for coastal planning aimed at preserving, developing and enhancing coastal resources in a balanced manner (GOV/USA/NOAA 2012c, Isely and Pebbles 2009, Norman 2009, Tomlinson and Helman 2006). The Act also calls for the coastal states to "manage coastal development to minimize the loss of life and property caused by improper development in flood-prone, storm surge, geological hazard, and erosion-prone areas and in areas likely to be affected by or vulnerable to sea level rise, land subsidence, and saltwater intrusion, and by the destruction of natural protective features such as beaches, dunes, wetlands, and barrier islands" (GOV/USA/NOAA 2012c, Norman 2009, Tomlinson and Helman 2006).

In recent years NOAA instigated a review of the Coastal Management Act. The subsequent Coastal Zone Management Program Strategic Plan 2007-2012 identifies sea level rise as a chronic threat to coastal communities, and considers the challenges faced in determining whether to rebuild and/or how to rebuild after major storms and/or inundations (Norman 2009). The U.S. Army Corps of Engineers, which provides guidance as well as builds and maintains many major water control structures, now considers future sea level rise in feasibility studies of projects.

Coastal setbacks in the United States are developed and implemented by state and local governments. In federal-state partnerships, NOAA provides the framework for coastal planning as well as technical and financial assistance to assist comprehensive coastal planning at both the state and local levels. Coastal planning is intended to protect lives and property, protect the natural environment, and maintain public access and aesthetic values (GOV/USA/NOAA 2012a, 2012c, Isely and Pebbles 2009, Norman 2009, Tomlinson and Helman 2006). Although participation by the states in coastal resource management and protection can be voluntary, most coastal states and territories now have approved coastal management plans developed in accordance with the national Coastal Zone Management Act (Davis 2004, Isely and Pebbles 2009). State plans have flexibility in content of their plans, and in their definition of the coastal zone. The legal instruments for implementation and enforcement can also vary, based on the individual legal structure of each state.

Most coastal states in the United States use setbacks to plan for and/or to manage coastal development (see summary table in Appendix D). The setbacks may be based on a fixed distance (20 to 200 feet (approximately 6 to 61m)) from a reference point or significant natural feature, on zoning or on erosion rates (Cheong 2008, GOV/USA/NOAA 2012c). Shorefront development is regulated in 94 % of US coastal states, and in 81 % no-build areas have been included in their coastal management plans. However, most states still allow exceptions or variances to the plan, based on unique site characteristics, and subject to specified conditions (Bernd-Cohen and Gordon 1999, GOV/USA/NOAA 2012c). Many of the state and municipal coastal plans and policies now address current sea level rise (Norman 2009, Tomlinson and Helman 2006) but only Maine explicitly considers future sea level rise in its no-build requirements (GOV/USA/NOAA 2012c). Some plans also address existing developments by limiting redevelopment or requiring removal of certain structures as the coastal hazards encroach (GOV/USA/NOAA 2012c). While state coastal management programs can affect development on hazard areas of the coast, most land-use decisions directly affecting individual developments occur at the municipal level, where changes to the coast over the next century and longer will require changes in existing planning approaches to development and buildings (Kling and Sanchirico 2009).

4.3.5.1 State of Florida

In states like Florida, where there has been a long history of coastal development controls and setbacks, coastal areas are still being rapidly developed and valuable natural habitats are disappearing (Hauserman 2007). Florida has two separate but related legislative tools to plan and manage coastal development: a Coastal Construction Control Line and an erosion projection setback. The Coastal Construction Control Line is defined as the predicted extent to which a 100-year storm event would cause substantial damage to buildings that lie seaward of the line. The State of Florida erosion projection setback requires that buildings be set landward of a line drawn at 30x the predicted annual erosion rate for the coast (GOV/USA/NOAA 2012c). Current policies and legislation do not generally address issues related to sea level rise and predicted increases in the severity and frequency of storms.

Reviews of coastal development in Florida have noted that it has been relatively common practice to allow numerous exceptions to these regulations(Hauserman 2007, Ruppert 2008) . The Coastal Construction Control Line is not a true setback in that development seaward of the line is regulated and requires special permits, but is not forbidden (Hauserman 2007). The 30-year erosion projection line also permits exceptions. The restriction on development does not apply to shore protection structures, minor structures, or some single-family homes (Ruppert 2008). Additionally, there is a line of construction provision, allowing that if there is a *reasonably continuous and uniform line of construction,* new construction may occur up to the same line, essentially obviating the need to work within both the Coastal Construction Line and the erosion protection setback (Ruppert 2008). There do not appear to be defined rules to determine whether the line of construction is either continuous or uniform. When used in combination with the ability to seek permits to develop within both the Coastal Construction Line and the 30-year erosion projection line, the legislative tools have done little to protect Florida's coasts from encroaching development (Ruppert 2008).

Encroaching development as experienced along Florida's coastlines is believed to directly contribute to acceleration of natural erosion rates by limiting the natural recovery of the beach/dune system following storm events, and through the construction of shoreline armouring (i.e. sea walls) which further affect erosion rates and patterns (Hauserman 2007). Continuing development on the shoreline will only exacerbate the vulnerability of coastal property to storm events and coastline change in the future.

4.3.5.2 State of Hawai'i

Hawai'i has established two different categories for the development of coastal setbacks. Specific areas have been defined as part of the Conservation District, which includes scenic and historic parks, wilderness, watersheds and water sources in need of protection, fragile habitats of local wildlife, and lands subject to flooding or erosion. The remainder of the Islands' shorelines that are not assigned to the Conservation District are part of the designated Shoreline Area (GOV/USA/NOAA 2012c). In the Shoreline Area, there is a mandated setback of 20 to 40 feet (6 to 12m), based on local conditions (GOV/USA/NOAA 2012c). In the Conservation District, the setback is more restrictive, and varies based on lot depth. The basic setback for in these areas is 40 feet (12m), which is applied to lots with less than 100 feet (30m) of depth. For lots over 200 feet (60m) deep, the setback must be 40 feet plus 70 times the average annual coastal erosion rate. Lots between 100 and 200 feet (30 and 60m) in depth may either use the same setback as mandated for lots over 200 feet in depth, or may add 10 feet to the setback for each addition 20 feet of depth past 100 feet, such that a lot 140 feet (43m) in depth would have a minimum setback of 60 feet (18m) (GOV/USA/NOAA 2012c).

Recently, concerns have arisen in Hawai'i, and particularly in Maui County, that the current system for coastal zone management may adequately account for erosion, but does not account for sea level rise (Norcross-Nu'u et al. 2008). While as recently as 2004 improvements to critical coastal infrastructure such as the Central Maui Wastewater Treatment Facility were re-assessed to take into account impacts from potential tsunami inundations, sea level rise was not included in these calculations(Norcross-Nu'u et al. 2008). This has raised concerns that while recognized as legitimate, have yet to be addressed.

Additionally, while these setback laws have been designed to account for the erosion of sandy shorelines, they do not necessarily translate well to the erosion of clay banks and bluffs, which make up many of Maui's coasts. Clay banks and bluffs can be especially vulnerable not only to ocean waves and spray, but also to the increased groundwater flow resulting from changes in irrigation, water leaks, or sumps associated with development; or with the focused runoff of rainwater from developed areas (Norcross-Nu'u and Abbott 2005). As a result the process of development can cause increases in the rate of erosion, exposing the development to an increased risk of being undermined by erosion significantly sooner than expected.

4.3.5.3 State of North Carolina

North Carolina has in place relatively strict coastal setbacks for planning development. The State uses two different measures to determine setback distances, with the larger of the two distances being adopted as the most landward setback requirement. The first method uses a simple measurement landward from the crest of the primary dune or frontal dune. Construction may occur landward of the setback line, as long as it also meets the second requirement. The second measure is based on either soil erosion rates or a set distance (whichever is larger), and varies based on the size of the proposed structure. In both instances that use this method to determine setbacks, the distance is measured from the first line of vegetation (GOV/USA/NOAA 2012c). The setback requirements as determined by the size of the structure proposed and the erosion rates are as follows:

- Structures less than 5,000 square feet must be set back 60 feet, or 30x the erosion rate, whichever is greater.
- Structures between 5,000 and 9,999 square feet must be set back 120 feet, or 60x the erosion rate, whichever is greater.
- Structures between 10,000 and 19,999 square feet must be set back 130 feet or 65x the erosion rate, whichever is greater.
- For each additional 20,000 square feet added to the building area, the minimum setback increases an additional 10 feet, and the erosion rate multiplier increases by an additional 5 times, until the setback distances are capped as for structures of 100,000 square feet or higher, which require a minimum setback of 180 feet, or 90x the erosion rate, whichever is higher.

In cases where substantial damage from coastal hazards has occurred to an existing structure, the same restrictions are applied to the application to rebuild. Owners may be denied permits to rebuild, forcing abandonment of the property. The application of the setbacks in this manner allows for changes to shoreline conditions and erosion rates over time. Structures that existed before the setbacks came into place are exempt only as long as the property does not sustain substantial damage from coastal hazards (Platt et al. 2002). Hurricane Fran (1996) scoured the North Carolina shoreline, removing in many areas the vegetation that would normally have been the benchmark against which the setbacks were measured. This left the State of North Carolina in an awkward position, as a literal reading of the setback requirements would have required a much larger setback for post-hurricane rebuilding than otherwise. The State chose instead to extrapolate properties that had existed within the setback area based on the original line of vegetation, rather than use the new, storm-established line of vegetation (Platt et al. 2002). The practice has opened the door for future reinterpretations of where limitations should be rather than where the law states they are, based on current coastal conditions. This will be particularly complicated should a storm significantly change the physical alignment of the coastline in the same way that Hurricane Fran changed the line of vegetation. A recent State legislature decision to disregard a comprehensive report on the implications of sea level rise for coastal management and planning in the State and only allow planning authorities to consider historical rates of erosion and storm surge in planning decisions received widespread criticism and is considered a significant maladaptation.

4.4 Synthesis on the Use and Effectiveness of Coastal Setbacks

In countries throughout the world, where development proposals include initiatives that span the land-sea divide, planning and management can be fragmented vertically across levels of government and horizontally through a number of responsible government departments and agencies (Ballinger et al. 2000, Few et al. 2007). Studies on coastal planning and management increasingly make reference to sustainable development, to the risks associated with climate change, and to the future costs of inaction on these challenges (UN/ISDR 2004a, 2004b, UNEP 2008a, 2009a, 2009b, UNEP/ECLAC 2010, UNEP/Risø 2010). Yet in most countries reviewed during this study, coastal hazard management and the protection of sensitive habitats and ecosystems have not yet been effectively applied through local land development management processes. While there is emerging guidance for planning for coastal development and for climate change (Boateng 2008, Snover et al. 2007, UN/ISDR 2004a, 2004b, UNEP 1996, 2008a, 2009b, UNEP/GPA 2005, UNEP/Risø 2010, UNESCO 2012), much of what has been proposed offers policy direction at the national or regional level and does not translate well, or has yet to be integrated into local development planning and management processes.

Coastal setbacks, intended to protect coastal environments from land-based activities, to protect land-based structures and uses from the sea, and to ensure public rights of access, are increasingly seen as a powerful land use planning instrument to deal with development conflicts and impending sea level rise. For the most part, throughout the LAC region, there is only limited information on the use of coastal setbacks as a development or conservation planning and management tool, and even less information on the effectiveness of established setbacks. Despite interest in the application of more proactive planning, especially for climate change adaptation, few of the jurisdictions examined have policy and/or regulatory instruments for coastal setbacks that continue to be effective when confronted by often conflicting demands for land ownership and use (Cordero and Bonilla 2006, Esquivel 2011, Higgins 2008, Muñoz 2001, Mycoo 2006, Seraval and Alves 2011).

The time horizons for local development projects and planning processes can be shorter than that which is required to anticipate and to proactively manage coastal processes, even when accelerated by projected sea level rise and severe weather impacts of climate change. Government decision-makers must already deal with the challenges posed by limited human and fiscal resources, and the conflicts that arise when coastal setbacks threaten the economic benefits of continued development in coastal areas. As a result, decisions being made today can too often reflect the short-term gains, deferring potential future costs of impending climate change impacts to other institutions and/or to future generations.

Global practice has demonstrated the difficulties in establishing a single setback distance that accommodates for erosion, inundation, the protection of significant coastal assets, and the provision of public access, and also includes planning for sea level rise and the effects of severe weather events. In the Mediterranean, where the Regional Sea organization has established a minimum 100m setback, the conditions for development planning are left to the individual nations. A fixed setback distance has the benefit of simplicity, but presents difficulties when implemented across a broad diversity of geomorphology, values and cultures. In the Caribbean, methodologies for calculating setback distances for individual beaches have benefits when considering a local development proposal, but may prove too cumbersome for application across an entire coastline. Calculations of setback distances require considerable data and expertise, which may present a further strain on human resources, even when the project proponent pays the costs.

In countries of the LAC, where coastal development planning employs setbacks, there is little consistency in the methods for determination of the objectives for setback implementation, and/or the rationales for setback design, or for the associated restrictions on building and use. Across the LAC, setback distances can be established arbitrarily, can rely on a historic practice, or can rely on recorded local erosion rates on the specific beach under development consideration. Setbacks that respond to changes caused by erosion can be an indirect link to sea level rise when climate change science is included in calculations of the rate of future change.
Within a few small island states (e.g. Nevis, St. Kitts, Anguilla) a shared approach for the development of local coastal setbacks for development has faced challenges in implementation. Where sea level rise projections result in setbacks that impact on existing or potential future coastal real estate, inaction on this matter, at least in the short term, quickly becomes a more favoured alternative. In some of the coastal states of the eastern United States, legislatures have recently proposed banning the inclusion of climate change science in calculations on erosion and other predicted changes to coastal geomorphology and flooding models, mandating that calculations of hazard and risk rely on the use of historic observations of changing water levels and beach movement (Phillips 2012).

As determined by this study, within the countries of the LAC region there are some shared impediments to more effective design and implementation of coastal setbacks, as well as continuing practices that may work against the successful implementation of setbacks. Additional conclusions drawn from this review of current setback practise include:

- There are few consistent policies or instruments that require coastal setbacks for new or existing development.
- There appears to be a general lack of knowledge and experience among decision makers regarding the economic benefits of development planning that includes setbacks, zoning, soft armouring and other risk averse options for coastal development and protection.
- The responsibility for coastal planning tends to reside at the national level of government, and is imperfectly interpreted, applied and enforced by local authorities.
- Where policies for adaptation to climate change impacts exist, responses to erosion and inundation along sheltered coasts continue to be more reactive rather than proactive.

- In practice, decision makers appear to be biased towards protecting existing and proposed new development through the construction of hard armouring options (i.e. bulkheads and revetments), despite the growing body of information on the need for better planning and adaptation options that take into account sea level rise and severe weather.
- There was little information that demonstrated where setbacks had been effectively integrated into other planning and management tools for coastal development.
- Even where coastal setbacks were an element of planning policy, universal application appeared to be difficult (e.g. Uruguay).
- In several countries, a form of setback has derived from colonial administrations that reserved an area of the backshore for use of the 'Crown' (e.g. St. Lucia, Costa Rica).
- Coastal setbacks are a significant instrument in the coastal planning policy of Cuba, where they are used in conjunction with other planning tools such as no-build area designations and buffers to protect sensitive environments and to manage development.
- Calculation of site specific distance requirements for setbacks is particularly challenged by the need for decades of data on local erosion rates, the inability to predict the extent of erosion and inundation impacts attributable to a severe weather event, and the need to plan for sea level rise and increasingly severe and frequent storms.

While on the surface the design and implementation of a coastal setback may seem a relatively simple planning and management task, in reality many efforts to implement coastal setbacks are overtaken by the complexities inherent in coastal environments, by conflicting values for coastal lands and resources, and by the need to promote high yield tourism development in nearshore areas. Despite these complexities, the economic, environmental and social benefits of professional design and thoughtful implementation of setbacks are widely argued to outweigh the short-term benefits of relatively un-controlled development in coastal areas and are expected to have even greater value in an era of climate change and sea level rise (UNEP/Risø. 2010).

5.0 Guidance on Coastal Development Planning: Basic Concepts and Best Practices

When planning for sustainable coastal development, projects should never be reviewed, assessed or planned in isolation from existing coastal conditions and stresses, and without due consideration for changing environmental, social and economic conditions. Whether it is based on current practices in integrated coastal management or ecosystem based management, today's best approaches to dealing with the complexities inherent in development along coasts rely on well-established goals and principles for guidance in both planning, designing and maintaining human activities. As noted by UNEP, "Policy and development planners require effective tools to develop, disseminate and build adaptation capacity, for example through building on existing planning frameworks (UNEP 2008a, p80).

The *Protocol on Integrated Coastal Zone Management* under the Barcelona Convention was the first effort by a Regional Seas organization to "endeavour to ensure the sustainable use and management of coastal zones in order to preserve the coastal natural habitats, landscapes, natural resources and ecosystems, in compliance with international and regional legal instruments" (EU 1995, p75). While nations party to the Protocol struggled to understand, implement and evaluate the benefits of the proposed guidance on coastal development, the world experienced a tragedy previously unimaginable in its impact on human life and property. The 2004 Sumatra-Andaman earthquake triggered a series of devastating tsunamis along the coasts of most landmasses bordering the Indian Ocean, killing over 230,000 people in fourteen countries, and inundating coastal communities with waves up to 30 metres (98 ft) high. In the years following the quake, nations have considered how best to deal not only with the rapid development and populating of coastal areas and the threats posed by unanticipated natural disasters, but also with the slow onset (creeping hazard) now associated with the sea level rise and severe storm impacts of climate change. In 2005, nations gathered in Cairo, Egypt voiced their support for a series of principles intended to guide future development in at-risk coastal areas (UNEP/GPA 2009). The Cairo Principles (see Appendix E) begin with an overarching commitment to the need to plan and manage coastal development so as to:

"Reduce the vulnerability of coastal communities to natural hazards by establishing a regional early warning system; and applying construction setbacks, greenbelts and other no-build areas in each nation, founded on a science-based mapped reference line".

The guidance provided in the following sections is consistent with the Cairo Principles. The principles and concepts proposed are intended primarily to assist the Bank in its considerations of opportunities and constraints associated with projects proposed throughout the Caribbean and Latin America Region. However the approach may also promote leadership and provide pragmatic direction towards advancing local and regional sustainability while protecting the socio-economic and environmental future of the nations the Bank seeks to assist.

5.1 Goals and Objectives for Coastal Development

The need to integrate the goals and principles of sustainable coastal management within land planning and management has been recognized for several decades (UNEP 1996). In countries around the world, planning and effective management of existing and potential future coastal hazards such as flooding, erosion, deposition and the resultant impacts to ecosystems and to human communities is complex, and highly fragmented among levels of government and sectoral departments (Ballinger et al. 2000, Mercer Clarke 2010, OECD 2009). There is growing evidence that reduction of risks and mitigation of hazards to ecosystems and to human populations offers the best path towards enhancing the ability of communities to withstand and/or to adapt to both insidious and catastrophic change (slow and rapid onset hazards) (Cutter 2008).

Coastal management policies still tend to be national or regional in scale and context, and only recently has it been recognized that implementation will be best accomplished through meaningful engagement of local governments (Tobey et al. 2010). Translating national and regional policies on coastal planning and management also needs the understanding and acceptance into practice of planning and design professionals (e.g. architects, engineers, landscape architects), developers and the public, many of whom remain unfamiliar with the need for, and with the short- and long-term benefits of such controls on development (Burby et al. 2000, Cambers 1998b). There is a continuing need for strong and effective leadership in coastal development planning. Leadership sets the vision and constructs a clear path for human use of the coast that is based on respect for the past, responsiveness to the needs of today, and proactive planning that anticipates future conditions and hazards posed by climate change and sea level rise (Boateng 2008).

This section proposes goals and objectives for coastal development planning and operation that are relevant in application at all levels of government, and by all parties in the development process. The proposed goals have been derived from the Cairo Principles, the Mediterranean Protocol, and from the goals and objectives of other initiatives in coastal development planning (CCCCC 2009, GOV/UK 2010, GOV/UK/DEFRA 2006a, 2006b, GOV/USA/USAID 2009, OECD 2009, Tomlinson and Helman 2006, UNEP 2009a). These goals, and the measureable objectives that guide their implementation have been derived from a number of sources (Ballinger et al. 2000, CCCCC 2009, Field et al. 2001, GOC/NB 2005, GOV/AUSTRAL 2009, GOV/AUSTRAL/WA 2012, IOC 2009):

1) REDUCE RISKS TO HUMAN HEALTH AND SAFETY

- assess and evaluate and avoid coastal risks, taking into account sea level rise and storm surge;
- protect the safety of residents, workers or other on-site occupants from risks associated with coastal processes;
- protect the safety of the off-site public as a result of coastal risks triggered by the development changes;
- protect public infrastructure (drinking water and wastewater systems) and protective features (wetlands, surface water bodies, aquifer recharge areas) to reduce damage from intensive precipitation, sea level rise and flooding;

2) MAINTAIN FUNCTIONING AND HEALTHY COASTAL ECOSYSTEMS

- protect coastal ecosystems from development impacts;
- maintain nesting, vegetation and migratory corridors and habitats;
- reduce the risk of invasions by non-indigenous species;
- prevent the disturbance of endangered, threatened or priority listed species and communities present in the area;
- reduce and control impacts from processes such as surface water runoff, nutrification and sedimentation that reduce the resilience of coastal ecosystems;.

- assist the sustainability of coastal wetlands by providing adequate buffers to allow their inland migration as sea water levels rise;
- protect landscapes and structures of unique ecological and cultural significance;

3) REDUCE EXPOSURE AND VULNERABILITY OF THE BUILT ENVIRONMENT;

- support development that avoids areas at risk from flooding and erosion, as well as areas where existing coastal defences would not provide adequate current or future protection from storm surge, severe weather and the projected impacts of sea level rise;
- encourage the siting and design of new structures so as to avoid the need for current (or future) coastal protection works;
- ensure natural coastal features (i.e. marshes, mangroves, dune complexes and beaches), and shoreline processes (erosion and deposition) continue to provide cost effective coastal protection;
- use engineered protection measures only after other options have proven ineffectual or impractical;

4) AVOID TRANSFERENCE OF COSTS FOR PRIVATE RISKS TO THE PUBLIC PURSE

- give consideration to equitable distribution and apportionment of costs and benefits of adaptation measures;
- reduce and/or avoid intensifying land use through appropriate strategic and land use planning;
- maintain the function of on-site infrastructure, services and utilities;
- ensure there are no detrimental impacts to off-site infrastructure, services, and utilities and that the demand for services posed by the planned development falls within the capacity of these systems;
- do not increase coastal risks to properties adjoining or within the locality of the site;

5) SECURE PUBLIC ACCESS AND USE

- maintain existing public beach, foreshore or waterfront access and amenity;

- make equal and full participation of the public a central element of decision-making processes;

6) MAINTAIN AND DIVERSIFY LIVELIHOOD OPTIONS AND OPPORTUNITIES; AND

- account for the distinct vulnerabilities of potentially affected subpopulations in adaptation planning;
- allow communities to determine the resources and features they value, e.g. beaches, public access, fisheries, etc., and to influence (to their satisfaction) plans to protect those resources;

7) STRENGTHEN GOVERNANCE FRAMEWORKS FOR COASTAL ADAPTATION;

- begin early to incorporate estimates of sea level rise and strategies for adaptation in local and regional planning processes;
- construct new development and maintain existing infrastructure in accordance with building code requirements for protection from severe weather and sea level rise;
- consider comprehensive and forward-looking water use and management policies that conserve water and reduce effluent nutrient and contaminant concentrations; and
- advise the public of coastal risks to ensure that informed land use planning and development decision-making can occur.

5.2 Assessing Coastal Vulnerability

Coastal areas are among the most complex landscapes in the world, supporting a myriad of nested and linked ecosystems that range from terrestrial forests to the marine benthos. Coasts are biologically productive, aesthetically pleasing areas that historically have been of great interest to humans, and as a consequence more than half of the global population live along or near shorelines. Not surprisingly, coastal environments throughout the world are deteriorating, some dramatically (Barange et al. 2010, GESAMP 2001a, 2001b, MEA 2005, Mercer Clarke 2010, Mercer Clarke et al. 2008, Miles 2009, NRC 2004, Sherman and Adams 2010, Steffen et al. 2004, UNEP 2007, 2008b, UNEP/CEC/IISD/WRI 2002, UNU-INWEH 2008). In planning for coastal development, it is imperative that existing conditions within the coastal environment have been identified and assessments conducted on the existing and potential vulnerability of coastal environments to changes in physical, chemical and biological factors. As reported by Mercer Clarke (2011), while change is a natural and on-going process, it is important to understand when anthropogenic influences have initiated deleterious change that negatively impacts the resilience and adaptive capacity of effected ecosystems. Even a coarse understanding of the pressures and stresses that already affect coastal conditions will be helpful towards planning for the future consequences of climate change.

In addition to established parameters for environmental impact assessment (e.g. physical, biological, chemical and climatic conditions), factors to be included in GIS-based inventory and analysis of vulnerability and exposure in coastal areas should include (Cutter 2008, Daniel and Abkowitz 2005a, GOV/AUSTRAL/WA 2012, GOV/UK/DEFRA 2006b, Mercer Clarke 2011):

- area of dunes
- average dune height
- average beach width
- coastal geomorphology, stability and erosion rates
- natural vulnerability
- acreage of wetlands
- wetland/habitat loss (% change from previous decade)
- acreage of undisturbed habitat
- tidal range (including seasonal extremes)
- wave climate exposure (wind fetch, coastal geomorphology)
- volume of riverine inputs
- coastal subsidence (rate per year)
- sediment supply from berms and offshore bars
- number and location of coastal defences (grains, jetties, seawalls, revetments)
- number and size of storm water detention basins and areas
- water contamination sources (piped effluents, surface water, ground water)
- 25, 50 and 100 year flood zone area delineations
- storm surge inundation zones and highest high water lines for 10, 25, 50 and 100 year storms

- land tenure
- land cover classification
- land use classification, including public access to and use of the coast
- scenic vistas and views
- area of impervious surfaces as compared to total area of watershed
- area of natural cover as compared to total area of watershed
- projected sea level rise for local area as based on most recent scientific literature.

Geographic information systems (GIS) provide for data and information to be reported, analyzed and presented in statistical as well as visual formats, improving understanding of cause and effect relationships (e.g. nutrient sources and coastal water quality), and communication of complex scenarios for growth management and its consequences to a wider, non-expert audience. GIS systems also allow for the collection and inclusion of traditional and local knowledge in improving understanding of past, current and potential future changes.

To better assess project development proposals, a range of data and studies are necessary including:

- Coastal environmental conditions, including 50 or more years of coastal erosion data,
- Coastal development plans (land use and growth management)
- Coastal hazards inventory, mitigation plans and hazard vulnerability assessments;
- Coastal climate change impact scenarios, including sea level rise projections and the propensity for increased frequency and severity of storms.
- Project Environmental Assessment and Risk Management Plan to include construction, maintenance, operation and de-commissioning activities over the estimated life of the development.
- Disaster/Emergency Response and Recovery Plans
- Land tenure and arrangements for properties within coastal rolling easements and/or no-build zones
- Zoning ordinances, setbacks, dune management and other tools used to manage coastal development
- Building Standards, Codes, Enforcement.

As was discussed in Section 4, the high information needs of some approaches to coastal setbacks can pose a fundamental barrier to implementation in many LAC countries.

5.3 Holding Back the Tide: The Dynamic Nature of Shorelines

One of the most complex issues in coastal planning is the inconsistency in defining what is meant by the *shoreline* (Gibbs and Hill 2011, Mercer Clarke 2010, 2011). Mapping of coastal water depths and mapping of land topography generally occurred as separate initiatives, resulting in difficulties when coastal managers need to integrate the two spatial data sets. Measures of mean water mean tide – the average sea water level- are not ordinarily rationalized with the 0.0 elevation on topographic maps. The most recognizable features of the shore are the ordinary high water mark and the seaward edge of permanent vegetation. In many jurisdictions, the high water mark (i.e. ordinary high water mark, high water high tide) has been used as the baseline for the measurement of the spatial extent of concepts such as coastal zone, beach, property ownership, and more recently setbacks. Using the high water mark as a baseline can be problematic, especially in areas where the high tide levels can sometimes vary daily and by as much as 10m when tidal cycles are affected by seasonal or storm related factors (Cambers 1997, 1998b). In the Caribbean, Cambers (1998b) noted that a single storm event can result in dramatic change, depending on the scale of the weather event and its distance from the affected coast (Table 3). Beach monitoring, which facilitates understanding of both short- and long-term changes in water levels and in beach morphology, can be a useful tool in proactive planning for coastal change.

Table 3: Coastline changes experienced by selected Caribbean islands as compared to their proximity to the centre of Hurricane Luis (1995) (Cambers

Island State	Distance (km) to the Center of Hurricane Luis	Average retreat (m) of the land/dune edge
Anguilla	28	8.9
Barbuda	5	17.5
Antigua	40	4.9
St. Kitts	70	4.0
Nevis	90	5.2
Montserrat	90	3.5
Dominica	180	2.5

In coastal planning for development, one of the most important concepts is the dynamic nature of shorelines, where sometimes significant changes can occur daily, caused by a range of forces that are the result of normal tidal and current action, seasonal changes, severe weather, historic patterns of sea level rise resulting from land subsidence and more recently, climate change (Douglas and Crowell 2000). To complicate matters further and because of the range of criteria that will affect the extent and rate of sea level rise in individual countries, and indeed, in regional and/or local areas, there is understandably no consistent benchmark for sea level rise (Gibbs and Hill 2011). As climate changes, sea levels are projected to rise and severe weather events are projected to become occur more frequently, resulting in creeping and sometimes catastrophic changes to beaches and potentially to other features of coastal geomorphology (IPCC 2012).

Whether the context is short- or long-term planning, water levels at the shoreline have become a less dependable benchmark against which to define coastal management areas, or setbacks for development. In some jurisdictions and applications, alternative physical features, such as the seaward limit of permanent vegetation or the dune crest, have been proposed as the preferred reference point for defining the shoreline, and for mapping spatial areas and planning boundaries (Gilman 2004, Gilman et al. 2006).

In general, the identification of appropriate benchmarks against which to measure change and set regulatory distances, should take into consideration most -if not all -of the following factors (Cambers 1997):

- slope and soil erodibility;
- naturally influenced and on-going changes in coastal geomorphological features (i.e. bluffs, exposed beach rock, offshore islands or shoals);
- recent (including storm-related) and historical changes in the shoreline;
- anthropogenic changes to coastal geomorphology (i.e. breakwaters, groins, dune and beach mining, beach replenishment, infilling);
- the seaward line of permanent vegetation and the nature and extent of vegetation cover in the area;
- human development impacts on coastal reefs, and other coastal ecosystems; and
- the cumulative effects of projected sea level rise and the potential for heightened storm surges on all of the above.

Given that many shorelines throughout the world have already been affected by catastrophic natural events and/or human activities, ***managed realignment*** (see Section 2.0) is becoming an alternative to hard engineering of shorelines and coasts. Managed realignment assumes that over long periods of time, shorelines had achieved a relatively stable configuration that has been interfered with and dramatically changed by storm events, and human construction. Most realignment initiatives focus on restoration of those conditions through removal or landwards relocation of the line of coastal defence measures (e.g. dykes, armoured sea walls) so as to return in-filled land to the sea, to allow for the return of natural beach erosion and sedimentation processes and to allow coastal vegetation (e.g. mangroves, marshes) and/or intertidal mudflats to develop (French 2006, Friess et al. 2008). The anticipated benefits of realignment efforts are increased wave attenuation and more natural and stable shorelines and shoreline processes, and the potential for reducing impacts from predicted sea level rise, riverine flooding and storm surges.

5.4 Planning for Coastal Adaptation to Climate Change

Coastal development and adaptation to sea level rise and other effects of climate change will involve important trade-offs that weigh environmental, economic, social, and cultural values (Ehler et al. 1997, Tobey et al. 2010). While it has often been the practice to rely on reactive engineering solutions to coastal erosion and flooding, more proactive planning is required if crippling costs are to be avoided and effective options identified and implemented in a timely manner. Non-structural adaptation tools such as setbacks and easements, zoning, site design guidelines and building codes, and the acceptance of financial risk, are ***gaining wider recognition*** as precautionary measures that employed today, ensure a more sustainable future for communities and ecosystems (Georgetown Climate Center 2011).

In coastal areas, it has been reasonably well accepted that the planning and management

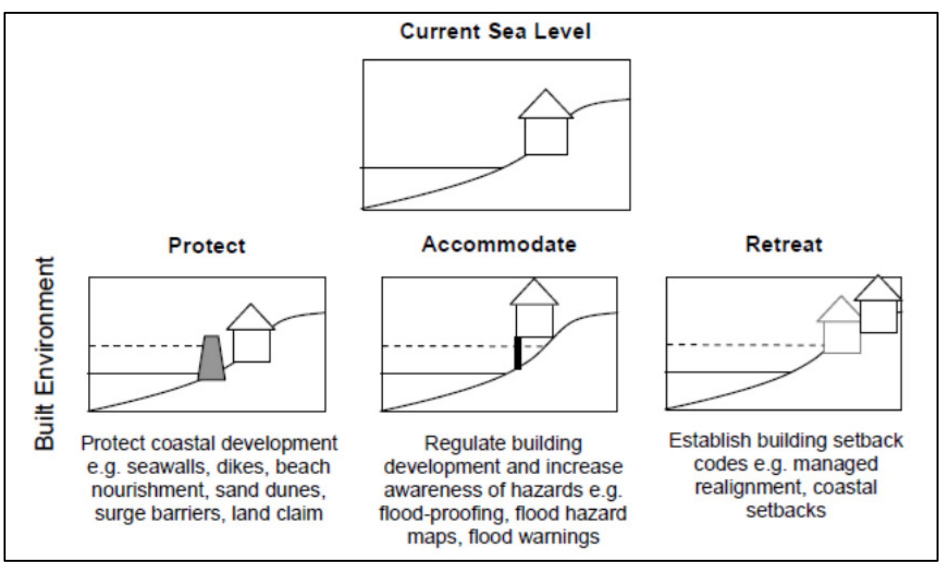

Figure 7: Schematic Representation of the Options for Coastal Development as adapted from (UNEP/Risø 2010, p13)

options for adaptation to climate change fall into three categories: protection; accommodation and retreat (Boateng 2008, IOC 2009, Macintosh 2012).

5.4.1 Protection

Protection options generally employ natural or artificial measures intended to reduce coastal hazards by holding the shoreline in its existing position, and/or by protecting inland areas, coastal infrastructure and buildings so that existing use of the area can continue (Bijlsma et al. 1996). Protection options employ an array of soft armouring and/or hard armouring measures that operate against natural forces, and may have detrimental, long-term indirect as well as direct impacts to other aspects of coastal environments. Protection measures are generally costly, require expert design, construction and maintenance and have a finite life cycle before costly repair and/or replacement is required. Climate change will challenge the effectiveness of existing and proposed shoreline protection measures as sea level rise and increasingly severe weather act cumulatively to reduce their effectiveness over time. Protection measures include:

- ***Hard structural options:*** dikes, levees, and floodwalls; cliff stabilization; offshore breakwaters; sea walls, revetments, and bulkheads; groins; detached breakwaters; floodgates and tidal barriers; barriers to saltwater intrusion;
- ***Soft structural options:*** periodic beach nourishment (sand replenishment); dune restoration; wetland creation; littoral drift replenishment; afforestation (planting of trees in areas where there had been no previous forest).

5.4.2 Accommodation

Accommodation options include the continued use of land at risk, without attempting to prevent land from being damaged by the natural event. Measures used to accommodate to sea level rise and severe weather allows the conservation and migration of ecosystems and reduces, but does not eliminate risk (Bijlsma et al. 1996). Accommodation measures must be justifiable in the context of safety and security as well as economic costs and benefits, even where there is uncertainty over the rate and extent of potential future changes such as sea level rise and severe weather (GOV/USA/EPA 2009). For accommodation options to be viable alternatives, there must be either low costs (low regrets) or no costs (no regrets) to the actions taken today, or the future benefits of protecting coastal assets (i.e. mangroves, marshes, coral reefs, public access, traditional use, historic sites and scenic views) and/or avoiding, delaying or mitigating serious impacts are considerable (Füssel 2007). Examples of accommodation measures include:

- strict regulation of use in hazard areas;
- using zoning to adjust permitted occupancy and use of existing structures until safety and security is compromised;
- modifying building codes and adapting existing structures to better withstand severe weather and flood event damage (e.g. raising foundations, strengthening wind resistance);
- elevating wetlands and beaches through reconstruction, and sand replenishment;
- increasing pipe sizes and pumping station capacity to meet demands of high precipitation events and rising water levels;
- incorporating criteria based on severe weather and sea level rise in transportation infrastructure maintenance and repair;
- changing permitted land uses in coastal areas (e.g. converting agriculture to fish farming, growing flood/salt tolerant crops);
- planning for evacuation and alternative accommodation during flood events; and
- providing publicly funded hazard insurance (disincentive to move).

5.4.3 Retreat

Retreat options accept that sea level rise and severe weather will inundate areas, ecosystems and structures and will curtail historic use of the area. Managed retreat from the coast does not attempt to protect the land from the sea, but rather seeks to provide well-thought out plans for the abandonment of areas, ecosystems and communities, and the landward shift of ecosystems and assets and the resettlement of people (Forsythe 2009, Titus 1998, Tomlinson and Helman 2006). Selecting retreat as the preferred option is generally motivated by the risks of continued occupancy and use, the costs and usefulness of protection and accommodation measures, and the long-term security and productivity of the assets under consideration (Bijlsma et al. 1996). Along those coasts where there is still sufficient unoccupied landward area and conditions are favorable, it is to be expected that coastal vegetation such as wetlands and mangroves may migrate with rising water levels. Where available lands are constrained by environmental conditions and/or human development, coastal vegetation impacted by rising water and increased salinities may deteriorate and eventually disappear. Managed retreat also attempts to secure area between existing development and the landward migrating shoreline, avoiding (for a time) the threats posed by creeping coastal hazards and preventing a squeezing of coastal ecosystems between rising water levels and existing development. Common retreat measures include:

- implementing and enforcing coastal no-build setbacks and density restrictions for new developments;
- rolling easements that permit new construction under stated conditions for its removal when shorelines migrate landward;
- enhancing building code requirements for new construction and replacement and repair of existing infrastructure;
- restricting capital improvements to existing structures;
- using zoning to alter human use of the coast to be in keeping with the new and projected realities;
- withdrawing government subsidies for damaged structures and/or impacted livelihoods (incentive to move); and
- targeted buyouts and relocation assistance.

Within some nations in the Caribbean, there is a propensity for land tenure to be held as ***freehold*** (i.e. there are no legal stipulations attached to the ownership), such that there is limited cultural understanding of the role of government land use controls (Lewsey et al. 2004). Lewsey et al. (2004) have recommended that for high hazard coastal areas where it is advantageous to begin phasing out human occupancy, there is a need to begin conditioning local residents towards the expectation that when a property owner dies, or sea levels become threatening, private land ownership in this areas will expire and residents will be relocated.

5.5 Sustaining coasts

Throughout the world there is continuing demand for development in coastal areas. Given the growing body of knowledge on the current and projected impacts of climate change to coastal and marine environments, it is becoming increasingly strategic for nations, institutions and the private sector to assume proactive, leadership positions that address the hazards, risks and liabilities of these rapidly changing environments and communities. Yet too often, even where coastal management policies exist, there are few examples of the effective application of controls on burgeoning coastal development, and even fewer examples where controls reflect the projected changes to coastal conditions attributable to sea level rise and/or to climate change. Recognizing these challenges, and the ongoing rush to develop the coast, a number of nations have moved to refocus existing development planning instruments and to establish new instruments and tools to better manage current and future development.

6.0 Guidance on Coastal Project Planning and Design

Unless dealing with a small or homogenous area, coastal development planning generally benefits from a multi-pronged approach to protecting people, coasts and property (Burby et al. 2000, Georgetown Climate Center 2011). No one development planning instrument may be able to effectively address all the issues needed to ensure safe, sustainable and environmentally sound development. Without clear, available and detailed regional and national guidance on established principles and instruments to manage coastal development and use, staff of the IDB can be challenged in their review of proposals for coastal undertakings within the nations of the LAC Region. Even where policy and instruments specific to the planning and design of coastal developments exist, there can be considerable variation in context, content and capacity in their application. While it is advantageous to have supporting national or local policy and legal instruments, many of the approaches and instruments discussed in these sections could be collaboratively applied (i.e. with local governments and authorities) in areas where coastal planning controls do not yet exist, or are considered to be inadequate to address all issues associated with the proposed undertaking, its operation and its decommissioning.

Effective selection and implementation of appropriate measures to assist in planning for sustainable coastal development must address a range of factors, and rely on locally specific criteria such as (IOC 2009, UNEP/Risø 2010):

BOX 1: Guidance on Coastal Adaptation

The IDB should assume that planning for climate change and sea level rise will become an integral aspect of coastal development and management, and that there will be a need to evaluate international policy and planning best practice of within the next 5 years (particularly subsequent to the release of the IPCC 5th Assessment Report in 2014).

- the costs (e.g. construction, operation and decommissioning, impacts to environment, loss of public access) and benefits (e.g. quality and duration of local employment, contribution to local economies) of the proposed development;
- the geographic scope and context of the proposed development, as compared to existing development in the area under consideration:
- the timeframe for construction and the estimated life cycle of the proposed development;
- the existing and potential coastal hazards that will affect the development throughout its proposed life;
- priorities for protection and conservation, as identified during vulnerability and risk analysis;
- the broader approach for coastal management (i.e. protect, accommodate, retreat) that has been adopted by the community (as well as local to national levels of government) to address risks associated with climate change;
- the long-term effectiveness, cost (including maintenance) and durability of coastal protection measures;
- the existing and potential future capacity (i.e. funds, expertise, equipment and other resources, administrative) of the project proponent and of the community to effectively address identified risks to environmental and economic sustainability;
- the political, legal and socio-economic context in which the proposed development will be constructed and will operate; and in all circumstances
- care should also be taken to ensure that priority is given to development that is dependent on the coast as opposed to that which is not.

This chapter provides guidance on coastal planning and design instruments and tools that have been used in other nations, including some nations in the LAC region, and the potential for application to undertakings in the LAC Region, whether implemented by nations, communities, or as a requirement for Bank investment. While the focus is on the application of coastal setbacks as a primary coastal planning tool, attention has also been paid to the potential for application of other planning instruments and tools such as zoning, development agreements, site planning and design guidelines, construction and operation codes and best practices, and economic incentive and disincentive instruments (Figure 8). While identification and selection of an appropriate mix of coastal planning and design instruments for each undertaking will of necessity be influenced by existing policies and practices for coastal management within the host nation, the Bank may have opportunities to positively influence strategic planning for coastal adaptation and sustainability.

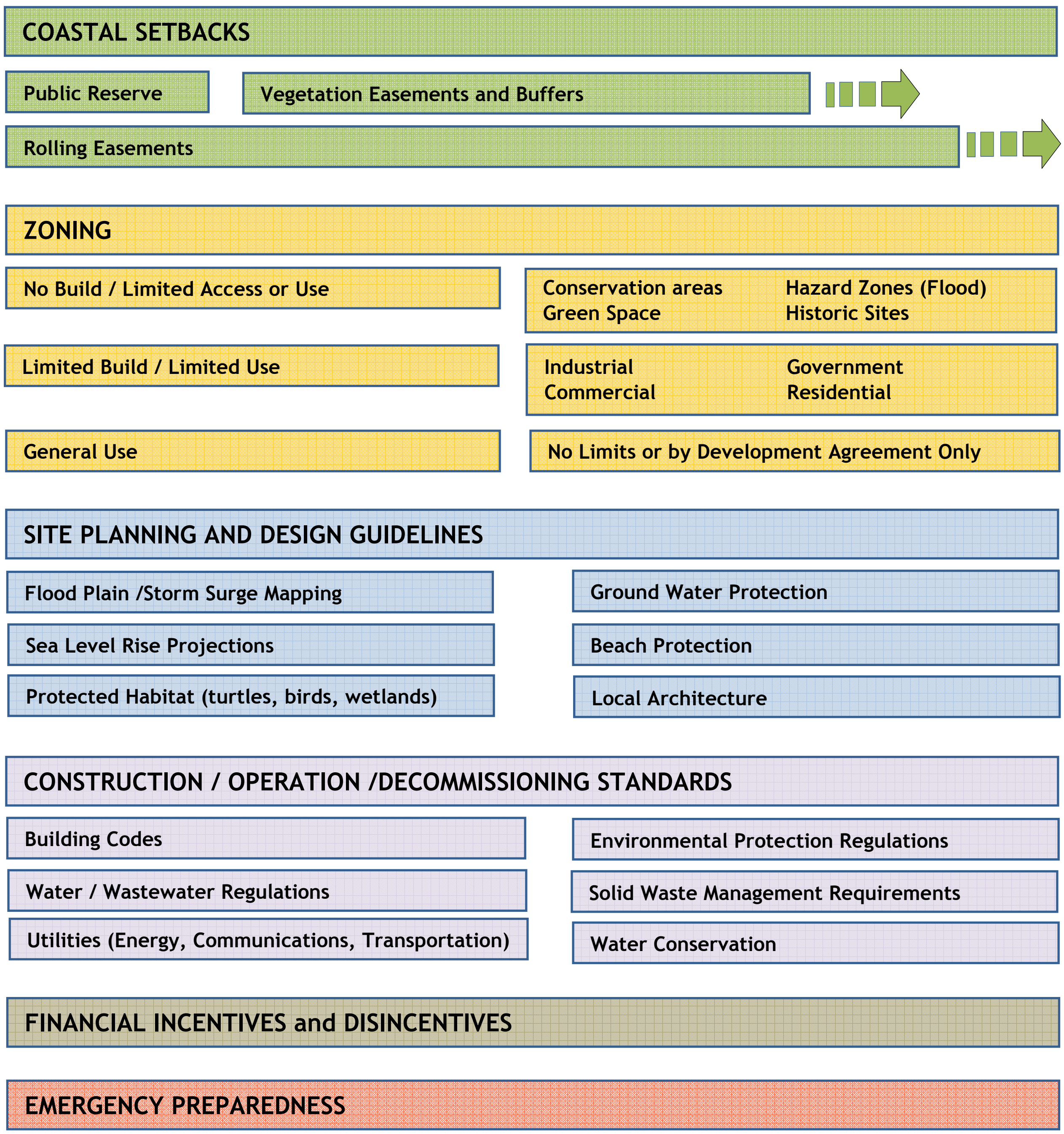

Figure 8: Graphic representation of coastal planning instruments and tools (Mercer Clarke and Clarke, 2012)

6.1 Coastal Setbacks – Hold the Line

Coastal setbacks are a prescribed distance to a coastal feature such as the seaward line of vegetation, the high water high tide mark, or the crest of a dune formation. Inside the area created by the setback, all or certain types of development are prohibited, and/or human use of the area can be restricted to approved activities only (Cambers et al. 2008, Georgetown Climate Center 2011). Coastal setbacks can be used to protect coastal features from development and human use impacts, and/or to protect development and human uses from the risks of impact from coastal processes (GOV/AUSTRAL/WA 2012, Sanò et al. 2008). Carefully designed and enforced coastal setbacks can be used individually or in combination with other coastal planning tools to achieve a range of objectives that include any or all of the following (Cambers 2009, GOV/AUSTRAL/ONSLOW 2011, GOV/BARB 2010, Rochette and Billé 2010, Rochette et al. 2010, Tollemache 2005):

- protection of human safety;
- reduction in damage to coastal property during extreme natural events (e.g., hurricanes, storm surges) or as a result of sea level rise due to climate change and/or land subsidence;
- protection of biodiversity and maintenance of ecosystem services;
- protection of significant cultural and indigenous heritage;
- protection of significant coastal features (e.g., beaches; eroding cliffs, headlands);
- protection of, and/or improvement of vistas and long views;
- provision of a buffer area between the ocean and coastal infrastructure, within which the shoreline can move, expand and contract naturally, and natural processes such as erosion and movement of sediments (e.g., beach replenishment) can proceed without interference from seawalls and other hard armouring structures;
- continuance of historic public reserves, and/or improvement of public access to the shore, with special provision given to local users and to the continuance of traditional use;
- improved privacy for shoreline residents and shoreline users; and
- increased public ownership of and participation in shoreline adaptation and restoration programs.

Setbacks and similar management methods can be applied by national and regional governments and/or by local councils. Well-designed setbacks encourage local support and self-enforcement, and allow communities and other local authorities to set boundaries that respect and respond to local issues and conditions. For coastal development managers, setbacks can be seen as a relatively low cost or no cost option for protecting property and coastal environments. Even where there is continuing uncertainty over future sea level rise, the costs associated with reduced tax revenues on shoreline properties can easily be compared to the long-term benefits for potentially avoiding or delaying serious impacts to populations, real estate, and environments (UNEP/Risø 2010).

6.1.1 Vertical and Horizontal Setbacks

Setbacks are generally intended to plan for and to manage new development within coastal areas. Setbacks consider current conditions, and may also include allowances for changing conditions, when determining the scope and extent of the setback requirements. There are two basic kinds of coastal setbacks:

- ***vertical setbacks*** that establish the minimum height above a sea level benchmark for the occupied floors of structures, and are intended to protect coastal infrastructure from inundation from storm surges and/or changing sea levels resulting from land subsidence and/or climatically influenced sea level rise; and
- ***horizontal setbacks*** that establish a horizontal distance from a seaward benchmark to define an area at greatest risk from coastal hazards (e.g. wave action, erosion, storm surges, and sea level rise); to ensure public rights of access, and/or to protect other values and cultural or ecological assets.

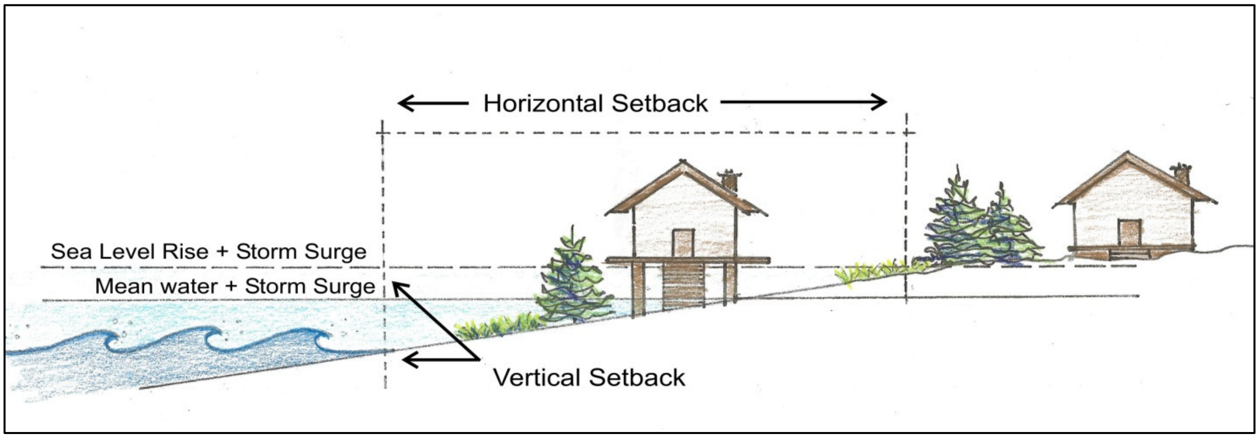

Figure 9: Vertical and Horizontal Setbacks (Mercer Clarke and Clarke, 2012)

In practice, vertical and horizontal setbacks may be used individually or in combination to ensure adequate protection from coastal hazards and to achieve multiple objectives. Vertical setbacks generally use historic data to establish the sea level benchmark, and to determine the minimum elevation required to mitigate impacts from current flooding and wave conditions. Increasingly, vertical setbacks are being used in low-lying areas as a proactive tool to adapt to and accommodate projected sea level changes.

The factors used to determine horizontal setbacks can be directly related to the objectives the setback is intended to achieve (i.e., reducing property damages from storms, protecting important ecosystems, preserving public access). Along beaches and eroding shorelines, setback distances can be based on the historic rate of shoreline erosion. Calculation of this rate can take into account shoreline erosion measurements (which also factors in slope), the changes brought by severe weather and associated storm surges, and increasingly, the potential for additional effects of sea level rise. The setback may dictate the minimum distance from the shoreline for new buildings or other infrastructure. In some cases it may be appropriate that setback distances are adjusted based on the size of the proposed structure (floor area) and related to the anticipated life of the proposed development. Larger, more substantial structures may be less vulnerable to coastal hazards, but may as well have a longer life expectancy and could subsequently face increasingly severe risks of damage.

When coastal features are chosen as the seaward benchmarks for setbacks (i.e., line of vegetation, high water high tide, dune crest) they can be non-permanent features whose locations move or *roll* as coastal alignments change, shorelines erode, sea levels rise and habitats disappear (Forsythe 2009). As coastal conditions change, whether related to climate change or not, sea level benchmarks may also change or *roll*. When designing setback instruments it is important to specifically state whether it is expected that:

- the benchmark will remain as it was established in the year in which the setback was put into place, or whether
- the benchmark will be periodically reviewed and adjusted, or whether
- the benchmark is understood to be a rolling benchmark, respective of changing coastal conditions.

Based on the criteria used to assign elevation and distance and to select the benchmarks, setbacks may fall into one of the following categories (Mercer Clarke and Clarke, 2012) (Figure 9):

1. A ***vertical setback*** based on a calculated minimum elevation above a permanently fixed sea level benchmark (e.g. a fixed tidal benchmark, a surveyed point on the shore); or as
2. a ***rolling vertical setback*** based on a calculated minimum elevation above a sea level benchmark whose position in the landscape may change over time.
3. A ***horizontal setback*** based on a specified distance landward of a permanently fixed benchmark (e.g. a fixed tidal benchmark, a surveyed point on the shore); or as
4. a ***rolling horizontal setback*** based on a specified distance landward of a coastal reference feature (e.g. seaward limit of vegetation, high water high tide, dune crest), whose position in the landscape may change over time; or as
5. a ***horizontal setback*** based on a calculated distance (which uses dynamic, natural phenomenon) landward of a permanently fixed benchmark (e.g. a fixed tidal benchmark, a surveyed point on the shore); or as
6. a ***rolling horizontal setback*** based on a calculated distance (which uses dynamic, natural phenomenon) landward of a coastal reference feature (e.g. seaward limit of vegetation, high water high tide, dune crest), whose position in the landscape may change over time.

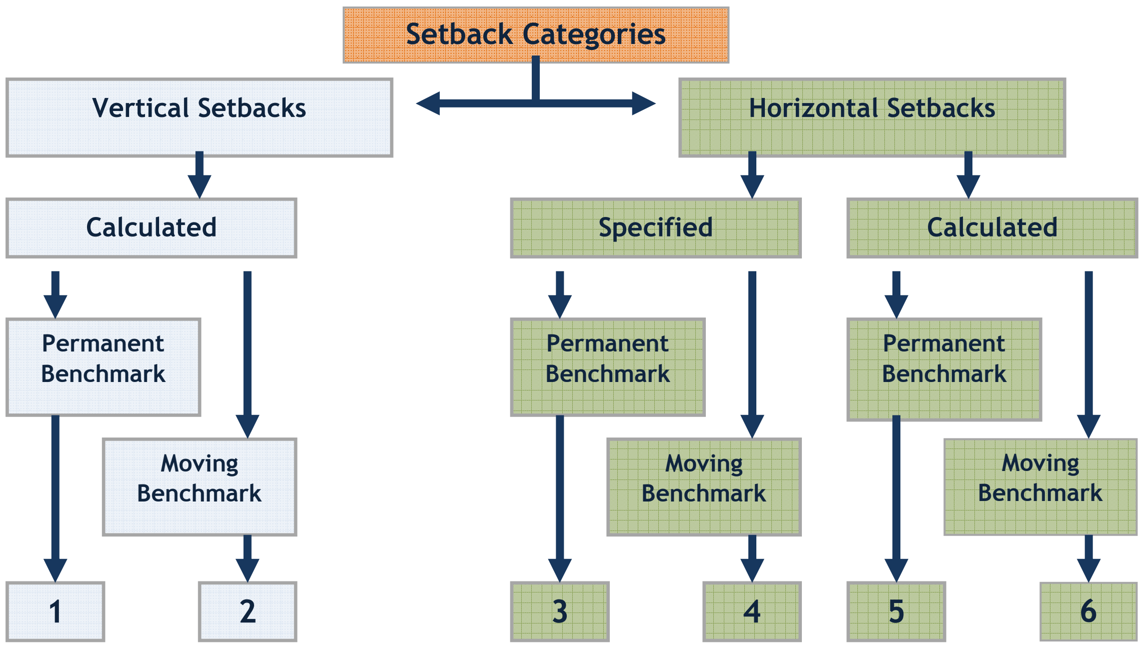

Figure 10: Setback Categories (Mercer Clarke and Clarke, 2012)

6.1.2. Calculating a Horizontal Setback

In practice, setbacks based on a specified distance and a permanent benchmark may provide a project proponent with a setback line established for the long term, there may be little allowance for changing coastal conditions such as erosion, storm surges or sea level rise. Ideally development setbacks should be established based on slope, erosion rates, extreme water levels and the potential for the cumulative effects of sea level rise, rather than on distances and/or permanent benchmarks which may not represent severe weather, long-term conditions or future coastal hazards (GOV/USA/FEMA 2011). While it is universally accepted that coastal erosion is affected by hard armouring and other structures that impede the littoral transport of coastal and offshore sediments, attention is increasingly being given to the impacts of frequent and severe weather events, and of the impending threat associated with projected long-term changes in sea level resulting from climate induced sea level rise and/or land subsidence.

In calculating coastal setback distances, it is important to understand the differences between shoreline erosion and beach erosion (Daniel and Abkowitz 2005a). Beaches change on a regular basis, from daily to seasonally. Natural processes such as winter storms can typically remove sand from a beach area, and it will normally be re-deposited in the summer, generally without long term changes to the size or location of the beach. Shoreline erosion is the often permanent landward movement of the beach when waves remove material behind the vegetation line (Cambers 1998c). Shoreline erosion, which is the focus of most setback considerations, is the result of the complex interaction of factors such as coastal geology and sediment supply, currents, wave action, storms, groundwater conditions and the nature and extent of upland vegetation (Daniel and Abkowitz 2005a, GOV/USA/FEMA 2011). Shoreline erosion rates can vary over time, and even over short distances along a shore.

A number of researchers (Cambers 2009, Daniel and Abkowitz 2005a, Gibbs and Hill 2011, GOV/AUSTRAL/WA 2006, GOV/NZ 2008) have developed formula to calculate coastal setback distances largely based on local shoreline erosion rates. The formula account for two kinds of shoreline erosion, acute erosion and historic or chronic erosion, and also factor in sea level rise as well as an allowance for uncertainty. Included in these calculations is an assumed time horizon, which often ranges from 60 to 100 years (Gibbs and Hill 2011, Hwang and Burkett 2009). In some analyses the time horizon used has been only 30 years (Cambers 2009), who based her calculations on the average expected economic lifespan of a building in the Caribbean. These formula are generally expressed as:

$$\text{Setback distance} = (A + B + C) \text{ X } D$$

where:

A is the setback distance needed to account for acute erosion from a major storm event;

B is the setback distance needed to account for historic or chronic erosion;

C is the distance needed to account for sea level rise; and

D is a safety factor which increases from 1 to 2 as uncertainty increases or to account for ecological, planning or social considerations.

Acute storm erosion is a short-term process that is normally calculated by modelling the local impacts of a severe storm such as an F4 hurricane. Computer models such as the United States Army Corp of Engineers' SBEACH model may be used. Modelling can be a complex task requiring local historical storm records to realistically determine the parameters for a locally severe storm (i.e., 1 in 100 year storm scenario) with corresponding waves and sea level heights (Daniel and Abkowitz 2005a, Gibbs and Hill 2011, GOV/AUSTRAL/WA 2006). In the absence of sufficient historic data, a default setback distance (such as 40m) may be arbitrarily assigned based on observed local conditions (Gibbs and Hill 2011, GOV/AUSTRAL/WA 2006).

Chronic erosion slowly moves the shoreline landward over a long period of time. The setback distance for chronic erosion is calculated by multiplying an assumed time horizon (ranging from 60 to 100 years) by the present annual erosion rate (Cambers 2009, Gibbs and Hill 2011, GOV/AUSTRAL/WA 2006). The annual erosion rate can be determined in several ways. By example, Daniel and Abkowitz (2005a) have developed a computer model for Beach Analysis and Management System (BAMS) in the Caribbean. The model can calculate beach erosion over the long term as well as erosion from storm events, and use the results to calculate setback distances. Alternatively, historical data gathered from beach monitoring, ground surveys, comparison of aerial photographs, review of historical maps, and local or traditional knowledge can be used to proposed a locally relevant chronic erosion rate (Cambers 2009, Gibbs and Hill 2011, GOV/NZ 2008). The historical record should cover a period of at least 50 years, to ensure that short-term weather patterns or other factors do not skew the analysis (Cambers 2009, GOV/AUSTRAL/WA 2006, Tomlinson and Helman 2006). Longer periods of record increase the level of certainty in the calculations and can reduce the safety factor used to adjust setback distance. If several methods of calculating chronic erosion yield different annual rates, the highest rate should be used for calculating the setback distance (GOV/USA/FEMA 2011). In the absence of sufficient data, a default setback distance (such as 20m) may be arbitrarily assigned based on local conditions (Gibbs and Hill 2011, GOV/AUSTRAL/WA 2006).

Factoring in sea level rise from climate change will result in increases in the horizontal setback distance. Where sea level rise in the area can be reasonably well determined through sources such as IPCC (2007a, 2007b) reports, the setback distance can be a simple calculation, that should still be validated against locally observed conditions and historical records. Where historical data are poor or non-existent, the Bruun Rule can be used to estimate the setback needed to accommodate the local impacts of sea level rise. Developed in 1954, the Bruun Rule is based on the premise that as sea level rises on a sandy shore, the sand will slump, be eroded and eventually be deposited offshore as the system seeks to regain an equilibrium profile (Cambers 2009, Cooper and Pilkey 2004). The net result of this activity is the landward movement of the shoreline where:

$$C = S / \text{tangent of } b$$

where

C is the setback distance attributed to sea level rise;

S is the estimated sea level rise; and

b is the average angle of the beach slope.

Under the Bruun Rule, each centimetre of sea level rise results in a shoreline retreat of one metre Cooper and Pilkey 2004, (Cambers 2009, Daniel and Abkowitz 2005b, Tomlinson and Helman 2006). While the simplicity of the Bruun Rule is attractive, and the concept has seen widespread use in at least 26 countries on six continents, the rule has had limited field testing, and some of the underlying assumptions have been severely questioned (Cooper and Pilkey 2004, GOV/NZ 2008). In addition to these and other limitations, the Bruun Rule was intended for application to uniform sandy shores without rocks or mud, but continues to be applied inappropriately to other types of shores.

Where setbacks are intended to protect coastal cliffs or bluffs (hereafter cliff) from development pressures, the geologic nature of the cliff structure (e.g. soils, stability), local wave conditions, and land processes (e.g., groundwater, surface water run-off) will individually and collectively affect erosion rates on the cliff face. Setback distances would normally be measured from the top edge of the cliff, but where cliffs have been undercut, the setback should be measured from a vertical line representative of the most landward progression of the undercut (Rochette et al. 2010, UNEP/Risø 2010). Setback distances should also be calculated taking into account other locally specific factors such as the geologic nature of the cliff, wave processes and terrestrial processes at the site, all of which can have a significant impact on the rate and extent of erosion on the cliff face. Prudent addition of a safety factor may be needed to account for uncertainties in geology or and/or the long term stability of the cliff edge, recognizing that cliff slumping is often a sudden process (Cambers 1998b, Forsythe 2009, GOV/USA/EPA 2009).

The use of formulas to calculate setback distances, while a useful too, are merely a better way to estimate the future progression of coastal changes. Calculation of coastal setback distances using these methodologies should err on the side of precaution especially as the scope and degree of uncertainty increases. Models are also useful but should also be employed with the same degree of caution recognizing that the process of converting complex coastal processes into mathematical equations can oversimplify the issues to be addressed and lead to results that are inappropriate for planning (Daniel and Abkowitz 2005a). The uncertainties inherent in theses calculated setback distances may be exacerbated as climate change increases the rate of sea level rise and the frequency and intensity of storms.

6.1.3 Rolling Easements - Advancing the Line

A rolling easement is a legal instrument that allows publically owned land, and/or land use restrictions to migrate inland as shorelines retreat and sea levels rise (Georgetown Climate Center 2011). Rolling easements, like coastal setbacks, are measured against a coastal benchmark (e.g., high water, dune crest or vegetated area). Because these benchmarks are expected to move dynamically with changing coastal conditions, the easement is said to "roll".

In general, rolling easements were established to ensure that as water levels changed and shorelines migrated inland, coastal vegetated areas could also migrate and still be protected from development pressures. Because the beach area and intertidal lands also migrate, public access to the shore may also be protected. Once an existing property falls within the easement, the rights of the owner to develop the property change significantly, and the risks to the owners investment and security are increased (GOV/USA/EPA 2009). Rolling easements generally contain conditions that prohibit new development, and may require the removal of existing structures, thereby preserving the viability of important coastal ecosystems and habitats (GOV/USA/NOAA 2012a, Hebert and Taplin 2006, Higgins 2008).

In the United States, a rolling easement is a legally binding instrument under which property owners have no right or expectation of holding back the sea should their property be threatened by erosion or inundation (GOV/USA/EPA 2009, 2011). Governments should not provide financial assistance for flood damage to properties that fall within the easement, nor should they protect existing structures by armouring eroding coastal features. Rolling easements generally prohibit property owners from expanding on existing structures, from rebuilding damaged structures, and from constructing their own hard armouring measures. They do not prevent owners from using the property until such time as coastal hazards render occupation unsafe. In some jurisdictions, governments may choose to buy the remaining private property, remove the structures and return the land to public use.

While they are not often described that way, coastal setbacks based on seaward benchmarks that move with changing coastal conditions are in essence a form of rolling easement. However, unless the responsibilities for risk are stipulated, property owners may still invest in their real estate expecting governments or other institutions to expend resources to sustain their property or to provide recompense for damages incurred by severe weather, erosion and flooding. When coastal setbacks are stated as rolling easements, the community has clearly decided to pursue retreat instead of shore protection as a viable option for coastal planning.

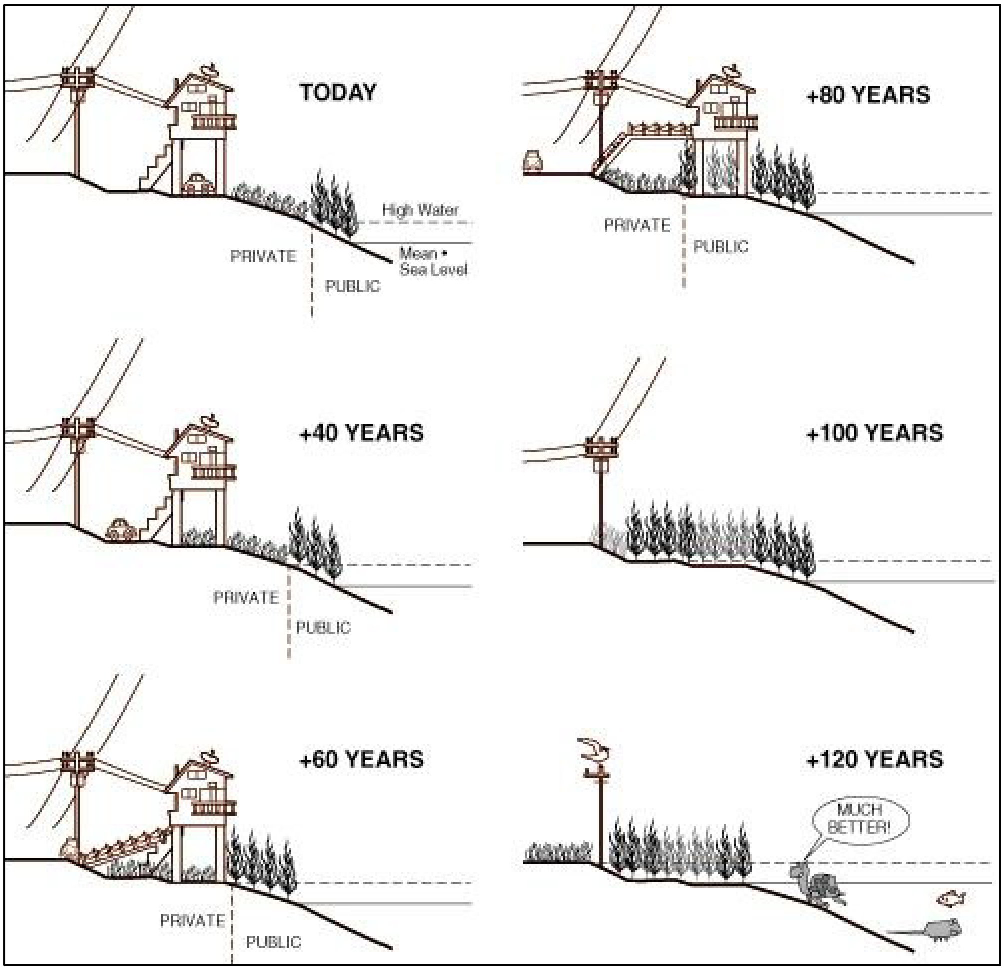

Figure 11: Rolling Easements as drawn by (Titus 1998, p29)

6.1.4 Conservation/Vegetation Easements and Buffers

In the literature, the terms *setbacks, easements*, and *buffers* can sometimes be used to mean approximately the same thing. Generally, a conservation easement (sometimes called vegetation easements, or open space easements) is a legal instrument used to protect special places (e.g., ecological habitats and corridors, historic or cultural assets, farmland, view lines) (Georgetown Climate Center 2011). Buffers are similar to easements and setbacks in that they require landowners to leave undeveloped designated areas of their property. Easements and buffers can be used independently or in addition to setbacks and other land development management tools (e.g. zoning, no-build areas) to avoid or minimize the negative impacts of adjacent land use and/or structures on designated areas of significant physical, cultural or ecological value (Desbonnet et al. 1995, Desbonnet et al. 1994, Georgetown Climate Center 2011, GOV/USA/RI 2008). As sea levels rise and the cost of coastal protection measures such as hard armouring increases, the value of coastal vegetation (and other natural shoreline features) to reducing the impacts of erosion, sea level rise and severe weather has become increasingly important (Costanza et al. 2008, Dahm et al. 2005, Gedan et al. 2011, Halfacre-Hitchcock and Hitchcock 2007, IUCN 2007, Lacambra et al. 2008). Protection of coastal vegetation has become an imperative in areas where migrating shorelines can squeeze habitats between the rising water and existing development (Horsely Whitten Group). Special conditions for coastal development have been developed in order to protect sensitive and often irreplaceable habitats such as turtle nesting areas (Choi and Eckert 2009, Fish et al. 2008, Mazaris et al. 2009, Varela-Acevedo et al. 2009), mangroves (Gilman et al. 2006, IUCN 2007) and sand dunes (Dahm et al. 2005, Judge et al. 2003, UNEP/CEP 1998).

Conservation easements generally allow land to remain in private ownership, but can also be applied to land donated to governments, to non-governmental conservation organizations and/or to land trusts. Where the land remains in private ownership, the owner has agreed to limit development and usage according to the terms required by the easement. Generally, once established, conservation easements are recorded with the deed to the property, and are transferred and binding on all future owners. In areas that are projected to be vulnerable to sea level rise, conservation easements could be used to prevent current or future development, prohibit infilling and/or the removal of vegetation, and limit or ban hard armouring of the shoreline. Easements can also be applied in estuarine areas and along the banks of tidal rivers, to extend the intent of coastal protection requirements inland (CRMC 2011). Application of a *rolling conservation easement* can also ensure that as sea levels rise and shorelines move inland, structures that encroached on or were absorbed within the public easement would have to be removed.

6.1.5 Public Reserves

In some nations, coastal public reserves had their beginnings with the designation of a strip of land measured from the high water mark and running along the shoreline as land owned by the Crown. This tradition has continued in some form in countries such as New Zealand and St. Lucia (Mycoo 2005). In Hawai'i, even where large tourism resorts occupy the backshore, perpendicular public access to beaches is protected and ensured through requirements for public parking and public access pathways. However, the concept of a public reserve that allows longitudinal access along the coast, is growing in interest, and efforts to enact such rights of public access are emerging in nations such as Australia and New Zealand. Public reserves, used in conjunction with, or in addition to, coastal setbacks and/or vegetation easements and buffers can extend inland the area in which private development is prohibited.

6.1.6 Summary of Coastal Setback Options

While much of the literature on coastal setbacks prefers to take a simplistic approach to design and implementation, in reality, effective and enforceable coastal setbacks must address local conditions, and be responsive to environmental, societal and developmental needs and pressures. Setbacks can be applied independently, or in conjunction with rolling easements, vegetation easements and buffers and/or public reserves. It is critically important that, before selecting the preferred option for setback design, the objectives to be achieved are clearly stated and understood and agreed upon.

Setbacks will be most effective when used in conjunction with other development planning and coastal management tools (e.g. easements, zoning, site design guidelines, building requirements). To minimize development conflicts, planning instruments that employ setbacks ***should also set out the rules for application and enforcement***. Clear descriptions are needed of both prohibited and permitted work or activities on the lands within the setback area, including the construction or alteration of new and existing buildings, structures and/or services, removal or alterations to existing vegetation, changes to coastal features as a result of excavation and/or filling (e.g. sand mining, infilling mangroves); and prohibited activities (e.g., vehicular use on beaches, hunting). Some suggested categories for review of development proposals and rules for the application of setbacks have been include in Appendix F. Careful attention should also be given to setting out a limited set of conditions under which exceptions may be considered, and the process and authority for approving an exception, and/or appealing a setback decision.

BOX 2: GUIDANCE ON COASTAL SETBACK OPTIONS

Depending on the identified Bank and country specific sustainable coastal management objectives and local conditions, coastal setback design can be based on one, or a combination of the options outlined below:

1. A ***vertical setback*** based on a calculated elevation above a designated historic high water high tide level. Calculation of the elevation should include an allowance for storm surge and wave action, plus an allowance for sea level changes associated with land subsidence and/or climate related sea level rise and storm surges, plus a safety factor to account for uncertainties. Vertical setbacks should be established for limited time periods, with a stated requirement for review and adjustment to allow for new information on changing coastlines, sea levels and severe weather.
2. A ***horizontal setback*** based on a specified 100m minimum distance from a designated seaward benchmark (e.g., the seaward line of permanent vegetation, the high water high tide mark, and/or the dune crest), consistent with the Cairo Convention, this position may change over time, plus any additional distance determined to be necessary to achieve the stated planning objectives.
3. A ***horizontal setback*** based on a minimum 50m distance from a designated seaward benchmark (e.g., the seaward line of permanent vegetation, the high water high tide mark, the dune crest, and/or eroding edge of a cliff or bank), whose position may change over time, **plus** any additional distance determined to be greater than 50m, taking into account the stated planning objectives, and as calculated based on the following requirements:
    a) the allowance for the historic patterns and rates of erosion in the local area as averaged over a minimum fifty year time frame, or extrapolated from data collected in nearby coastal areas;
    b) acute erosion which is understood to be the credible change in shoreline conditions and erosion patterns and rates that has resulted from severe storms (i.e., storms with 1% probability of occurrence in any one year);
    c) an estimation of sea level rise based on IPCC models and local projections, and extrapolated for appropriate intervals (5, 10, 25, 50, 75 years) and projected for the expected life of the proposed development or at least 100 years, whichever is shorter; and
    d) a safety factor that allows for uncertainties associated with all of the above.

6.2 Zoning

Zoning is an ancient land use planning tool employed by local governments to segregate uses that are considered to be incompatible to existing residents, businesses and environments. Zoning has been used to regulate the kind of development (e.g. commercial, residential, industrial, green space), but has also been employed to regulate densities, structural design, lot coverage and hazards such as flood plains.

In recent times, integrated approaches to the management of nearshore waters has largely been based on definitions of a coastal *zone*, which was often limited on the landward side to the high water mark, or to a limited distance inland of that mark. Responsibility for coastal management initiatives has often been marine, national and/or regional in scope, and insufficient attention has been given to integration with local governance instruments for planning and management of land use (Mercer Clarke 2010). In many areas of the world, especially within developed coastlines, coastal management initiatives have not been particularly successful in promoting sustainable development practices, or in curtailing the impacts of land-based activities to coastal waters (Mercer Clarke 2010). Too often in the Caribbean, the push to develop along the coast has resulted in highly vulnerable *ribbon* growth patterns of development that concentrate tourism infrastructure, and more importantly, critical transportation as well as water and wastewater services in areas highly vulnerable to storm events and to sea level rise (GOV/USA/NOAA 2002). As development pressures on the coasts grow and the threats of climate change force re-evaluation of traditional planning and management practices, there has been increased interest in the use of land-use zoning as a tool to promote more sustainable use and development of areas under threat of coastal hazards, and to protect ecologically significant areas and habitats (Cheong 2011).

Whether implemented at the local level of governance or across larger scales (e.g. state, province, country), establishing development and conservation controls on coastal lands can be a significant regulatory instrument for the planning and management of both existing and new development. Designation of areas can assist in the local assessment of new development applications, and also in granting building and occupancy permits for the repair of structures and homes which now fall in areas known to be at risk from coastal hazards, whether related to seasonal storm events and flooding or to sea level rise (Forsythe 2009, Titus et al. 2009). In the United States, the Federal Emergency Management Agency (GOV/USA/EPA 2009, GOV/USA/FEMA 2011) has used flood zones to specifically designate land use and construction requirements as a means to improve management of flood insurance and federal liabilities:

- ***V-Zones:*** coastal floodplains subject to more severe damage from storm-induced velocity wave action, where development is strictly regulated and subject to a different insurance rate structure;
- ***A-Zones:*** upland areas or riverine floodplains vulnerable to the 100-year flood, but not subject to wave action.

Zoning of hazards lands (i.e. flood areas), which are generally no-build areas, is also an established tool in many municipalities, but the practice is being expanded to include coastal hazards such as erosion, storm surge and wave action as well as lands designated for protection (e.g. marshes). Recommended zoning categories for coastal areas include the following range of designations (Georgetown Climate Center 2011, GOC/NB 2005, GOV/USA/EPA 2009, GOV/USA/NOAA 2012a, 2012c):

- ***Protection zones:*** areas with critical infrastructure and dense urban development, where soft coastal armouring measures are recommended but hard armouring measures may be permitted;
- ***Accommodation zones:*** areas where new development may be permitted but is limited in intensity and density, use of hard coastal armouring is limited, new structures are required to meet revised design and construction standards, and existing structures must be retrofitted to be more resilient to wind and flood impacts;
- ***Retreat zones:*** areas where hard armouring is prohibited, rebuilding of damaged structures is limited or prohibited, removal or relocation of periodically or permanently inundated structures can be required, and where combinations of regulations and incentives (e.g. tax benefits, property acquisition assistance) encourage landowners to relocate structures to upland areas; and
- ***Conservation zones:*** areas where local governments will institute no-build/no protection/no repair restrictions, limit private and public access and use, and seek to acquire private property in order to preserve and enhance important natural resources, ecosystems, habitats, or to improve natural buffering of wave, erosion, and flooding forces.

6.2.1 Conservation/No–Build Zoning

Zoning could be equally useful in the identification and protection of ecologically and culturally significant areas, including view lines and areas of historic public use. When lands are zoned as ecologically, culturally or aesthetically important, they usually carry restrictions on coverage, type and use of development. Re-zoning of privately owned lands as conservation lands can adversely affect private property values, and restrict the activities of current occupants and/or owners. While this may create short-term conflicts, it can also make public acquisition of conservation lands more feasible (Cummiskey 2001).

In coastal areas, conservation zoning can be used alone or together with coastal setbacks as a planning and regulatory tool to guide more sustainable development and use (Cummiskey 2001). Properties eligible for conservation zoning could include lands intended for the protection of:

- fresh and salt water marshes and other wetlands;
- beaches, dune complexes, and estuaries;
- scenic vistas;
- sensitive ecosystems and migratory and nesting habitats;
- existing and future drinking water well fields, aquifers and recharge areas; and
- public reserves used to provide for public access, trails, recreational use and/or traditional resource and livelihood use.

In some jurisdictions (e.g. Cuba, Western Australia), areas designated through conservation zoning as no-build areas may also carry setback requirements along all perimeters that further buffer the protected area from permanent development.

BOX 3: GUIDANCE ON ZONING

- The development and enforcement of comprehensive coastal land use and zoning plans (by national or local governments) should be encouraged.
- Areas at high risk to coastal hazards and areas of cultural or environmental significance should be designated as no-build zones.

6.3 Site Planning and Design Guidelines for Coastal Areas

Traditional practice in site planning and design begins with an inventory of existing conditions on the proposed site, an assessment of the processes and functions of the natural environment, an assessment of existing development in the area together with the status of local services (e.g. water, wastewater, storm water, power, transportation, communication), and an analysis of the best potential layout for the proposed development that takes into account its impacts to the local environment and its demands on local services (UNEP/CEP 1996). To aid development planning, different levels of government, according to their jurisdictions and responsibilities, may have developed guidelines for planning and design to aid proponents in their understanding of local conditions and local requirements for development (GOC/BC 2011, GOC/NB 2005, GOV/AUSTRAL/WA 2012, GOV/BARB 2010, GOV/UK 2010, GOV/UK/DEFRA 2006a, 2006b, GOV/USA/FEMA 2011).

Guidelines may identify preferences and/or requirements at a range of planning scales. At the regional scale, planning guidelines may describe in general the preferred style of development (i.e. clustered buildings and roads as opposed to ribbon-growth along the coastline), as well as specific requirements such as on-site sources for potable water, and for wastewater treatment prior to disposal, protected area zoning and coastal setbacks for development (GOC/NB 2005, GOV/AUSTRAL/WA 2012, GOV/BER 2004). At the local level, guidelines may determine exactly what can be built and how it is to be built if it is to meet with speedy approval from local agencies (Halifax Regional Municipality 2007, Saltwater Coast 2012). Guidelines may also provide information on the scope of exemptions that might be considered and the appeal process, which must take place prior to receiving planning and construction approvals.

Planning and design guidelines for coastal protection measures, especially hard armouring measures, are widely available, and often provide significant detail on appropriate siting and use and on engineering design and implementation (GOV/USA/FEMA 2011).

General guidance on the protection of shorelines from coastal erosion and inundation now tend to focus less on protection (hard engineering options) and more on managed retreat or accommodation options. Guidance on the development and effective implementation of coastal setbacks has been limited but is growing, although available documents are often focussed on

BOX 4: GUIDANCE ON COASTAL PLANNING AND DESIGN GUIDELINES

There is a need for a Coastal Planning and Design Guideline that could be shared across the LAC and used to inform the development of planning policy and to assist in decision-making. However, as with all of the guidelines listed below, the development of such a tool should be done in consultations with major regional stakeholders (see Sections 6 – Recommendations):

Examples of the scope and content of an array of guidelines used to assist planning and design for coastal development can be found at:

Halifax Regional Municipality. 2007. ClimateSMART: Climate Change: Developer's risk management guide
http://www.halifax.ca/climate/documents/DevelopersGuidetoRiskManagment.pdf

The Kapiti Coast District Council, New Zealand. 2009. Rural subdivision design guide.
http://www.kapiticoast.govt.nz/Documents/Downloads/Rural-Subdivision-Design-Guide.pdf

The Government of New Zealand. 2008. Coastal hazards and climate change: A guidance manual for local government in New Zealand. http://www.mfe.govt.nz/publications/climate/coastal-hazards-climate-change-guidance-manual/coastal-hazards-climate-change-guidance-manual.pdf

The State of North Carolina. 2002. Coastal shoreline buffer rules.
http://dcm2.enr.state.nc.us/Rules/buffprop.htm.

The State of New South Wales, Australia. 2003. Coastal design guidelines
http://www.planning.nsw.gov.au/LinkClick.aspx?fileticket=VYjmQirQlAk%3d&tabid=177&language=en-US
http://www.planning.nsw.gov.au/coastal-design-guidelines

The State of Western Australia. 2012. State Coastal Planning Policy guidelines
http://www.planning.wa.gov.au/dop_pub_pdf/SPP_2_6_Guidelines_Review_Public_Consultation_Feb_2012(1).pdf

jurisdictions or specific goals (i.e. protection of coastal vegetation, rural subdivision development) (GOV/AUSTRAL/NSW 2008b) (CRMC 2011, David Lock Associates 2008, GOV/AUSTRAL/NSW 2003, GOV/NZ 2009, Saltwater Coast 2012). In recent years, a number of state and local governments have compiled guidance documents that are not only intended to inform proponents of coastal developments on the constraints and potential hazards of development at or near the shoreline, but also to place responsibility on the project proponent (GOC/NB 2005, GOV/AUSTRAL/NSW 2009, 2010, GOV/AUSTRAL/WA 2012, Halifax Regional Municipality 2007). Some guideline documents give only general information, while others require proponents to provide justification for their desire to develop within designated coastal hazard areas, and to provide expert technical studies substantiating how they will address the existing and long-term hazards and demands on services that can be associated with these coastal sites (Halifax Regional Municipality 2007). Planning and design guidelines could also be used to define the expectations of lending institutions and other investors, as well as insurers.

6.4 Construction and Operations Standards

For many coastal developments, associated facilities such as wastewater treatment and/or disposal systems, access roads and parking areas, airports, marine docks and recreational and commercial marinas are often located on or near shorelines. Construction and operations standards to guide and regulate these activities can include an array of legislated regulations, building and maintenance codes and best practice guidelines intended to ensure the stability of infrastructure, public safety and environmental protection. Because of the mix of government organizations that can have jurisdiction over activities within coastal areas, national, state/provincial and municipal policy and regulations can apply to coastal development. Increasingly, regional, national and local building codes are one of the most effective measures used to guide and to regulate construction and operation of nearshore development, and especially to respond to the hazards created by climate change.

6.4.1 Building Codes

As reported by the United States National Oceanic and Atmospheric Administration (GOV/USA/NOAA 2002) studies conducted worldwide have shown that strict adherence to building codes and standards can reduce the destruction caused to coastal structures by extreme weather events and climate variability. In Florida, for homes built in accordance with modern building codes to reduce vulnerability to hurricanes, the frequency of claims was reduced by 60 percent, and the amounts of the claims by 42 percent (Sussman and Freed 2008). Somewhat perversely, building code requirements and the application of newer construction methods and materials, when applied in relative isolation of other hazard planning and management instruments, can result in increased damages and/or liabilities attributed to storm impacts. As reported in Lewsey (2004), the shift from traditional Caribbean architectural styles to more vulnerable forms of construction has resulted in reducing the quality of infrastructure, and in increased damage to buildings during hurricane events. Platt et al. (2002) and Dehring (2006) have suggested that in the United States there is a potential that the moral security associated with strengthening homes has actually increased the public's willingness to rebuild in hazardous areas, despite the stated risks. Generally, the demand for strengthening building code requirements is most evident immediately following the damage incurred by a costly storm event. Because of the delays between the triggering event and the development of new standards, implementation and enforcement of these standards may not take place in time to prevent damage from the next storm event (Cheong 2011).

The revision of building codes for structures in coastal areas (Georgetown Climate Center 2011, GOV/USA/EPA 2009, GOV/USA/FEMA 2011, GOV/USA/NOAA 2002, Lewsey et al. 2004) could include instructions to:

- limit or prohibit the siting of new structures in areas designated as retreat or protection zones (Section 5.5), and restrict the siting of new public buildings to exclude vulnerable uses such as schools, hospitals, recreational facilities, and emergency response services;
- modify architectural and engineering designs and specifications to, in addition to the historical data typically used to calculate stresses, include allowances for changing climate conditions (i.e. maximum sustained winds, 5, 10, 25 and 100 year storm projections, sea level rise and storm surge);
- alter and improve construction techniques that take into account strengthening important connections (i.e. the ridge board, between the joists and the top plate, between the floor and the foundation, at the foundation footing), and the use of longer joiners (i.e. screws, nails, hurricane straps) as well as the use of stronger roofing materials;

- wet proofing existing and proposed structures by elevating (e.g. on pilings) buildings in areas at risk from inundation resulting from storm events and/or sea level rise, through the designation of minimum floor elevations, piling depths, bracing requirements, and limiting approved use of the lower levels created (i.e. storage but not occupancy). In areas of extreme coastal hazard from wind driven waves and currents, building code requirements can also require special anchoring of the structure;
- dry flood proofing existing structures to a minimum elevation above current and/or anticipated sea levels through waterproof design and construction practices that employ special coatings to seal walls, and elevating or protecting mechanical, electrical, and plumbing equipment (such as toilets) against flood damage;
- add such additional changes to building codes and construction specifications and practice as are needed to reduce costs of damage and loss and protect human safety.

An additional use of building code requirements specific to coastal areas and/or coastal zoning is to set area restrictions related to building size, and/or lot coverage, and/or residential density to control what can and cannot be constructed. Hwang and Burkett (2009) reported that under its Dune Rules, the US State of Maine requires that structures with a floor area in excess of 2,500 sq ft (232 sq m) must not be under threat from shoreline changes that may occur within the next 100 years. Similar constraints were then recommended for buildings in Hawai'i where the planning horizons for coastal setbacks argue for 70-year climate change scenarios for structures greater than 2500 sq ft and 100 years for structures larger than 5000 sq ft (464 sq m)(anticipating that structures this large would be constructed from more durable materials).

An important first step towards introducing and enforcing revised building codes in individual Caribbean countries has been the introduction of the Caribbean Uniform Building Code (CUBiC), a regional building standard. In the Eastern Caribbean, a model building code, based on CUBiC, has been developed by the Organization of Eastern Caribbean States to facilitate the introduction of national codes (Wason 2002). However, given current climate change projections, the adequacy of CUBiC should be reassessed - efforts should focus on incorporating these regional standards and the specific instructions listed above into each country's regulations and land use plans. Traditionally, in the Caribbean, existing building and planning statutes do not specifically reference building codes; instead, legislation has focused on safeguarding health and property by proper planning and siting.

In general within the Caribbean region, planning law and processes do not universally reference building code requirements but focus on safeguarding health and property through appropriate site selection and planning. Efforts have been ongoing towards the development and shared enforcement of a Caribbean Uniform Building Code (CUBiC), but there have been concerns that the Code had not yet adequately addressed issues related to climate change(GOV/USA/NOAA 2002). A summary of the status of building codes in countries of the Caribbean is provided here as Table 4.

Table 4: Summary of Building Code Status in Caribbean Nations (compiled from Wasson 2002 and GOV/USA/NOAA 2002, p 18)

Country	Status (as of 2002)	Building Code Application
Anguilla	Completed	Anguilla Building Ordinance mandates the use of the Anguilla Building Code. The Code will be incorporated into the new Physical Planning Ordinance (administered by the Department of Physical Planning).
Antigua and Barbuda	Completed	Based on OECS model building code. Legislated in 1996 as regulations under the Development Control Ordinance.
Bahamas	In operation since mid-1970s	Based generally on the South Florida Building Code
Barbados	Draft completed 1993	Technical provisions based on CUBiC. Proceeding to establish a Building Authority and appoint Building Inspectors.
Belize	No national building code	Belize City Building Code in place from 1963. Belmopan has building and planning regulations. The Belize Chamber of Commerce and Industry draft technical standards for Belize building construction and a residential construction guide completed in 1999 and were being reviewed for legislative approval by the Attorney General's office.
Dominica	Draft Code based on OECS model	Submitted for legislative review. OECS Model Planning Act used as the basis of a new Dominica Physical Planning Act which will mandate the use of the Building Code.
Grenada	Draft Code completed	Based on OECS model building code.
Jamaica	1984 Draft Code not adopted Revised code under consideration	Building by-laws in each of the Parishes and in Kingston-St. Andrew.
St. Kitts and Nevis	Code approved	Mandated for use by the Development Control and Planning Bill 2000. Building Code and Building Guidelines included as the second and third schedules.
St. Lucia	Code approved	Based on OECS model building code. Physical Planning Bill drafted and forwarded for legislative approval.
Trinidad and Tobago	Code drafted and under review	Small building code being drafted based on Chapter V of CUBiC. For engineered buildings British, American and Canadian codes are used as standards.
Turks and Caicos Islands	Code approved 1990, regular use since 1991	The technical requirements of the Code are based generally on CUBiC. The Department of Planning and members of the building fraternity of TCI carry out revisions to the administrative sections of the Code.

BOX 5: GUIDANCE ON BUILDING CODES

- Local building codes should be strengthened so as to address enhanced requirements for coastal hazards and for projected climate change impacts.
- Where local building codes are insufficient to deal with coastal hazards, relevant standards developed by other regional jurisdictions should be applied.
- The availability, coverage and rates of property insurance should be linked to the quality of construction (compliance with national codes or international best practice).

6.5 Development Agreements

A development agreement is generally a contract between a local jurisdiction and an individual or organization that own or control property within the jurisdiction and wishes to develop that property. Development agreements can be used to specify the standards and conditions by which development may take place. In some jurisdictions, development agreements are used to the project proponent's benefit, by stipulating the rules and regulations in effect at the time of approval, and confirming that the development will not be subject to subsequent changes in regulations. Development agreements can also benefit the local jurisdiction when specific conditions, not necessarily in place in other planning and construction instruments, must be met to assure that a project at a specific location does not have unacceptable impacts on neighboring properties or to community infrastructure (Georgetown Climate Center 2011). Development agreements have also been used to provide clarity to the timing and sequence of construction and operation, to regulating when and what improvements can be made to the approved development concept, and to clarify the responsibilities of all parties towards improvements to publicly owned infrastructure and amenities.

In some municipalities, development agreements are used for large projects (e.g. subdivision developments, commercial properties, waterfront developments) that may require special conditions related to the existing environment, planning for anticipated future hazards, and the protection of valued assets (e.g. tree cover, watercourses, shorelines, view planes). Development agreements may also include specific instructions regarding the design and construction of the project such as setbacks, lot coverage, maximum height, construction materials, and surface water collection, treatment and disposal. Such an agreement can also facilitate enforcement of development requirements, since it is a binding contract that explicitly details the obligations of the project proponent and of the issuing authority.

In jurisdictions where land use and/or construction instruments are limited, or have not been developed sufficiently to address specific issues associated with proposed development, development agreements can draw on appropriate requirements from other jurisdictions to bolster controls placed on the project proponent, ideally for the lifetime of the project (i.e. planning, design, construction, operation and decommissioning and/or demolition). Financial and insuring institutions can also use development agreements to legally define conditions for the project funding and project insurance. By example, where coastal setbacks do not exist or are insufficient to protect either the environment or the development, the financing institution could require planning to incorporate a coastal setback for a range of purposes, including the protection of mortgaged assets throughout the expected life of the investment.

BOX 6: GUIDANCE ON DEVELOPMENT AGREEMENTS

- Development agreements should be used to entrench site specific conditions for development, especially in areas where other regulatory requirements (such as setbacks) are absent or insufficient to address the Bank's goals and objectives for sustainable coastal development.

6.6 Economic Incentives and Disincentives

In their 2008 report on the costs to Caribbean nations of inaction on climate change, Bueno et al. (2008) projected that, if global inaction to adequately reduce greenhouse gas emissions continued, the economic liabilities associated with climate change (i.e. hurricane damage, tourism losses, and infrastructure damage due to sea level rise) could reach $46.2 billion in US dollars by 2100 (21% of the total GDP). Bueno and his colleagues are not alone in their concern for the growing liabilities that face many Caribbean countries (CCCCC 2009, Lewsey 2004, (CCRIF 2011). Indeed, as reported by the Caribbean Community Climate Change Centre (CCCCC 2009), the current damages associated with severe weather events is not manageable (Table 5).

Table 5: Economic Impact of the 2004 Hurricane Season in the Caribbean (CCCCC 2009,p8)

Country	Natural Event	Economic Impact (in US$)
Bahamas	Hurricanes Frances and Jeanne	$ 551.00 Million
Cayman Islands	Hurricane Ivan	$ 1.62 Million
Dominican Republic	Tropical storm Jeanne	$ 296.00 Million

Country	Natural Event	Economic Impact (in US$)
Grenada	Hurricane Ivan	$ 889.00 Million
Haiti	Hurricane Jeanne	$ 296.00 Million
Jamaica	Hurricane Ivan	$ 595.00 Million
Total		**$ 4.247 Billion**

Similar concern over threats to coastal infrastructure, environments and human safety and well-being are being echoed throughout the world, but few people have paid attention to the often dramatic estimates of economic damage, and the associated consequences to human safety and well-being (Heinz Center 2000). Business interests in the tourism sector (and other sectors) have not adequately addressed the physical risks to private and public sector assets that may be incurred as a result of a changing climate (Scott et al. 2012b). Failing to plan for climate change may be due in part to perceived uncertainties on projected changes, the long-term context in which these changes may take place, or more pressing current issues which take precedence and are the focus of often limited resources (Sussman and Freed 2008). However, when planning for coastal development, there is at least increased certainty that for both global economics and climatic conditions, continued reliance on trends observed in the past is a poor option for accurate prediction of the future.

In the face of these growing realities, it is unfortunate that the policies and practices of governments and financial institutions continue to support unsustainable development in coastal areas, creating increasingly severe liabilities to public as well as private funds. Not only are there few economic incentives to locate new development at safe distances from the coast, responsible siting for infrastructure such as hotels and resorts could reduce their ability to compete for tourism revenues. In their review of integrated management approaches, AID Environment (2004) identified four categories of economic incentives that could be or are used in decision-making associated with development in coastal areas:

- ***Positive incentives:*** measures that are designed to encourage beneficial activities (e.g. relatively lower property taxes on developments located inland of coastal setbacks, that reduce energy and water consumption, and that contribute to local employment);
- ***Disincentives:*** measures that penalize developments for unsustainable activities or environmental impacts (e.g. higher rates for water and energy consumption,

fines/restoration requirements for damage and/or loss of local vegetation and biodiversity, penalties for failures to treat wastewater);

- ***Indirect incentives:*** measures that affect positive change through proactive employment of alternative planning and design measures (e.g. on site conservation of water reduces volumes of water requiring treatment and disposal; water treatment contributes to the longevity and productivity of coastal assets such as mangroves and coral reefs, coral reefs attract tourism and mangroves reduce vulnerabilities to storm damage); and
- ***Perverse incentives:*** measures that reward unsustainable behaviour (e.g. uncontrolled coastal development; no preferential taxation or service rates for developments that attempt to conserve coastal resources and environments; failures to enforce environmental protection law).

Factors affecting which incentives are chosen by developers include:

- consequences of complying and/or failing to comply;
- complexity, costs and effectiveness of the alternatives over the timeline required;
- local, national and international political and social acceptability;
- compatibility with other political, economic, environmental and social goals; and
- compatibility with market interests.

While governments have borne a considerable responsibility for all four forms of incentives, in reality much can be accomplished through other institutions both to overcome perverse incentives (e.g. continuing to provide financial investment and or insurance for infrastructure within coastal hazard and/or coastal setback areas), and to offer positive incentives for managed retreat from the coast (Georgetown Climate Center 2011).

6.6.1 Risk Acceptance and Insurability

Planning for impacts of sea level rise must responsibly address uncertainty through a risk based approach to management. Risk management is simply a process for setting the best course of action to reduce or eliminate risk, even when there is uncertainty about either or both the threats under consideration and the potential outcomes of the actions taken (Noble et al. 2005). Estimating risk is tied to understanding the probability and/or frequency of occurrence the threat. In the case of climate change, the debate continues over the lack of *certainty* that the threat (e.g.

hurricanes, sea level rise) will actually happen. Outside of statistical probabilities, decision-makers can adopt a more pragmatic and realistic understanding of probability and certainty, similar to the model proposed by CARICOM (CARICOM 2003) and outlined in Table 6.

Table 6: Frequency or probability rating of risk as adapted from (CARICOM 2003).

Hazard	Very Unlikely to Happen	Occasional Occurrence	Moderately frequently	Occurs Often	Virtually Certain to Occur
Individual threats identified through a coastal hazards assessment	Not likely to occur during the planning period	May occur sometime but not often during the planning period	Likely to occur at least once during the planning period	Likely to occur several times during the planning period	Happens often and will happen again during the planning period

As reported by Walsh et al. (2004) and suggested by Jones and Phillips (2011), a similar, pragmatic assessment of risk could rely on the probability of exceedance of critical thresholds as triggers for planning policy and development decisions. Critical thresholds link unacceptable levels of harm to a key climatic or climate-related variable. For many nations within Latin America, these variables could be a range of projected sea level scenarios that are based on key climate, topography and use variables.

"Building in highly hazardous areas must be totally discouraged both by regulations and by appropriate risk bearing. People who build on flood plains, on steep slopes, or along erosive shorelines should be discouraged from doing so ". (UNEP 2008a, p79)

Where there continues to be significant uncertainty and/or debate as to the extent and nature of hazards associated with development on or near the coast, an alternative option is to assign the costs associated with decisions that do not address the risks of coastal hazards to the individuals and organizations making those decisions, as opposed to expectations that governments not involved in the decision-making process will assume the costs of impacts should they occur (GOV/USA/EPA 2009). Policies and practices that specifically warn property owners that protection will neither be provided nor permitted and that no restitution will be made for damages or losses incurred will act as a deterrent to continued development in these areas.

It should be common sense that individuals and corporations should not be able to transfer costs for irresponsibly taken private risks to the public purse or to others. But the reality is that in many nations development is permitted in coastal hazard areas without significant financial penalty to the property owner. In the United States, there are growing conflicts over the availability of the National Flood Insurance Program, which in some cases can provide financial security to landowners who build and rebuild in at-risk coastal areas, often in conflict with other coastal hazard risk reduction initiatives (Dehring 2006, Platt et al. 2002). While there is a need to provide humanitarian assistance to affected communities and individuals during times of crisis such as the aftermath of a hurricane, there are few credible explanations for why the public should continue to support perverse expectations of the right for compensation by individuals that defy known hazards to invest in properties at or near eroding and flooding shorelines (Georgetown Climate Center 2011, GOV/USA/EPA 2009, Titus 1998).

In areas of the State of California, some municipalities have implemented legal instruments such as setbacks and rolling easements to ensure that property owners are aware of present and potential future risks to their real estate, and that the measures they may take to protect their property, or the compensation that they might expect for damages are significantly limited. Also of interest, in a few jurisdictions, property owners are required by law to disclose to potential buyers exposures to natural hazards or risks (e.g. siting in a designated flood plain). Similar requirements could require disclosure concerning property that is vulnerable to flooding and erosion from projected sea level rise changes (Georgetown Climate Center 2011).

BOX 7: GUIDANCE ON ECONOMIC INCENTIVES AND DISINCENTIVES

- Development in high-risk areas should not increase the risk or liabilities for others.
- Individuals should not transfer costs for private risk to the public purse or to others.
- Insurance, private or public, should not be made available to landowners who knowingly build structures that occur in areas known to be vulnerable to coastal hazards.
- Link property insurance availability, coverage and rates to compliance with the siting of new and existing structures within coastal hazard areas, and/or no-build, no-repair, and no-protect designated areas.
- Land owners whose property lies within high hazard areas should be made aware that ownership of land will expire with the death of the landowner, or when the sea level reaches a specified mapped location (with attendant public compensation).
- In most situations, compensation for damages to structures that occur as a result of known coastal hazards should not be provided to people that knowingly, and with alternative options, chose to build in harm’s way.

6.7 Emergency Preparedness

As sea levels rise and storms push water levels further inland, the safety of people, property and infrastructure are at greater risk (GOV AUSTRAL 2009, GOV NZ 2008). Planning and preparation increase the resilience of communities to withstand the effects of an emergency (Cutter 2008, GOV/NZ 2008, UNEP/IDB 2007). In coastal areas, where communities depend largely on a single economic sector such as tourism, vulnerabilities to disaster can increase. Emergency management plans address these challenges through identification and reduction of risk, readiness to respond, actual response to emergencies, and disaster recovery planning. Risk reduction can be enhanced by assessing the vulnerability of critical facilities and support systems such as transportation, power, food and water (Cutter 2008, UNEP/IDB 2007). Advance planning and preparedness is needed to ensure that these critical facilities and systems will be available in times of emergency. For new and existing coastal developments, identification of critical infrastructure, services and evacuation routes will help to minimize risks and to reduce vulnerabilities during extreme events and in the aftermath. When considering planning options for coastal development, strategic reviews must periodically be conducted to update not only emergency response plans, but to review and potentially relocate resources necessary for effective implementation (Cutter 2008).

Catastrophic conditions also often impact critical elements of emergency response plans, rendering them unavailable or less useful (e.g. flooding of roads, airports). For new coastal developments, it is important that attention be given to alternatives for planned evacuation routes, as well as to on-site preparedness and ability to withstand projected storm conditions over an extended period of time. Planning must also take into account the potential for interruption of supplies and services (water, wastewater, power, communications, transportation, health) that may continue past the period of the storm event.

Coastal development planning tools such as zoning for no-build areas, setbacks that protect existing beaches, dunes and vegetation, and local design and building codes that improve the resilience of structures to severe weather can significantly reduce the risks posed by coastal hazards to local infrastructure, environments and communities (Cutter 2008). Setbacks that prohibit development in high hazard areas of the coast can reduce damage, loss of life, and the necessity for emergency rescue during storm events (IUCN 2007).

7.0 Guidance on Assessment of Coastal Development Proposals

This Chapter outlines an approach for a preliminary review of a proposed undertaking within a coastal area, and has as its primary focus, the application of setbacks as a development planning tool. Where the IDB is considering investment in a proposed coastal undertaking, Bank staff may need to assume one of two roles. In contexts in which national and local governments have well developed policies and instruments on coastal development planning, together with the capacity for effective implementation of sustainable coastal practices, Bank staff can be more comfortable in relying on local leadership in coastal development planning. In situations where the Bank staff is less comfortable with the capacity of local governments and local instruments to provide needed guidance on coastal development, especially as related to the capacity to address increasing hazards related to climate change, Bank staff may feel it appropriate to take a greater leadership role, and potentially to draw on expertise from other sources.

Comprehensive information is needed in order to assess the sustainability of the infrastructure, as well as to protect the environment and to ensure human health and safety, both in the immediate and longer term. To assist staff in their deliberations on the risks and opportunities associated with coastal undertakings, the Chapter provides a preliminary outline of typical project assessment information requirements (Table 7) and a checklist of information appropriate to the potential impacts of climate change and the coastal adaptation measures proposed (Table 8).

Table 7: Typical project assessment information requirements

PROJECT DESCRIPTION	IMPACTS & RISKS
• Location and Siting • Property Ownership • Financial Arrangements	**Construction Phase** • Natural Hazards • Alteration or Removal of Natural Habitats and Cultural Sites • Erosion and Sedimentation • Solid and Hazardous Wastes • Occupational Health and Safety • Socio-economic Risks
Legal &Regulatory Framework • IDB Environmental and Social Policy • Environmental Regulatory Instruments • Public Health and Safety • Construction and Operation Codes and Standards	**Operations Phase** • Wastewater Treatment and Disposal • Water Supply and Consumption • Invasive Species • Energy Supply and Consumption • Air Emissions and Greenhouse Gases • Solid Waste Generation and Disposal • Hazardous Wastes Storage, Use and Disposal • Emergency Preparedness • Occupational Health and Safety
Environment & Social Setting • Geology and Soils • Climate • Coastal Geomorphology • Coastal Hazards • Surface and Groundwater • Flora and Fauna • Land Use • Local Air Quality • Local Noise • Socio-Economic Conditions • Water and Wastewater Supply • Solid Waste Management • Transportation	**EVALUATION** • Monitoring and Reporting Program • Beach Stability Monitoring Program • Sustainability Plan

Table 8: Adequacy of information provided on coastal adaptation measures (adapted from UNEP/RISO 2010 p134)

YES	NO	CRITERIA
		Effectiveness in mitigating potential sea level rise and severe weather impacts to natural environments
		Effectiveness in mitigating potential sea level rise and severe weather impacts to built environments
		Value of flood avoidance
		Value of erosion avoidance
		Ease of construction
		Durability/Maintenance requirements
		Flexibility in the face of climate change impacts such as sea level rise and severe weather
		Sustainability in projected time frames of 10, 25, 50, 100 years
		Implications for changes to beach and shoreline sustainability in local area
		Implications for changes to beach and shoreline sustainability in nearby areas
		Impacts on coastal flora/fauna
		Effects on tourism
		Degree of specialist knowledge/equipment required
		Total costs
		Social acceptability
		Social equity
		Effect on local economy
		Impact on public access to and use of the shoreline
		Implications for changes to beach and shoreline sustainability in local area
		Implications for changes to beach and shoreline sustainability in nearby areas

7.1 Guidance on Coastal Setbacks

Focusing on the identification of coastal hazards and the application of coastal setbacks, a series of key questions has been provided to guide Bank staff in their evaluation of project environmental reviews and in the assessment of planning, design, operation and decommissioning information.

PROJECT DESCRIPTION

- Is the project site located in close proximity to the coast or does it require access to the coast?
- What are the land tenure arrangements for properties on the project site?

LEGAL & REGULATORY FRAMEWORK

- What are the current national and local policies and regulations with respect to coastal development?
- Do the existing coastal management doctrines meet the goals and objectives of coastal sustainability as outlined in Section 5.1?
- Is there a coastal development plan that includes the project site?
- Are there any required coastal setbacks that would include project buildings, or other facilities or uses?
- Are there any required traditional setbacks for public facilities, or for public access and use?
- Are there any designated protected spaces, or no-build areas on or near the proposed site?
- Are the above requirements adequately enforced in the jurisdiction? What government department leads this effort?
- Does the intended use of the site meet current zoning standards?
- Is there a development agreement between local authorities and the project proponent?
- Does the information provided on the development agreement include details on the conditions for construction and operation of the proposed project? Is there a time frame for completion of construction?

ENVIRONMENT AND SOCIAL SETTING

- Has an Environmental Impact Assessment been carried out?
- Does the EIA include documentation on:
  - coastal geomorphology and coastal hydrodynamics;
  - bedrock and soil conditions, including erodibility, sedimentation and beach replenishment;
  - surface and ground water;
  - coastal flora and fauna, and habitats and species of concern;
  - local existing and project land use and land cover;
  - cultural and historic sites;
  - traditional use of the shore and the coast;
  - coastal risks and hazards to land and water infrastructure and use;
  - project services such as water supply (source and recharge areas), wastewater treatment and disposal, stormwater management, electricity supply, communications and transportation;
  - the anticipated changes to local climate conditions to include sea level rise, storm surge, and the frequency and severity of future storms;
  - estimated life of the project, including construction, operation, and decommissioning?

SETBACKS

- Does the EIA provide adequate information on the requirements of an existing legislated setback for this coastal area?
- If there is a proposed project -specific setback, is adequate information provided on:
  - the basis for calculation of the project specific setback;
  - the rationale for selecting the baseline from which the setbacks are applied; and whether the baseline will be permanently fixed; periodically revised, or rolling;
  - data on coastal erosion and beach conditions over 30 years or more;
  - data on storm frequency and intensity over 30 years or more; and on
  - projected sea level rise over the next XX years (NOTE: Bank staff should determine where they will set the time line (e.g., the life of the project, the life of the Bank's investment, or one that adopts a long-range sustainability perspective of 50-100 years)?
- Where a horizontal setback is proposed, does the calculation of setback distance address:
  - chronic/historic erosion;
  - acute erosion from major storm events;
  - projected sea level rise; and
  - a factor of safety to account for uncertainties in all of the above?

  NOTE: the Bruun Rule as outlined in Section 6.1.2 should only be used to estimate the setback requirements due to sea level rise, and should only be applied to sandy beaches without mud or rocks. Where the Bruun Rule is used, developers should increase the setback distance by an additional factor of safety.
- If the calculated setback proposed by the project proponent is less than 50m, will it provide sufficient long-term protection for environments, facilities and investments?
- Is there a vertical setback in addition to the horizontal setback? How was it calculated?
- Are there any permanent structures located within the setback?
- Does the setback proposed by the project proponent provide for public access to or public traverse of the shoreline, public use of the nearshore, and for privacy for the development?

CONSTRUCTION AND OPERATION

- Is there an applicable national or local building code?
- What was the basis for the original code development?
- Has the code been recently updated to include conditions that respond to the potential impacts of climate change?
- Does the code allow for traditional architectural methods and materials to be used on site?
- If there is no local building code, which construction standards are being employed?
- Have they been evaluated for appropriateness of use in the project environment?
- What existing regulatory standards govern the siting, distribution, and treatment of potable water?
- What existing regulatory standards govern the collection, treatment and disposal of wastewater?
- What are the conditions for solid waste collection, storage and disposal?
- What are the requirements and systems for stormwater collection and disposal?
- Is there a disaster/emergency response and recovery plan?
- Is there a beach stability monitoring program? To whom does it report and how frequently?
- Has the project proponent provided adequate information on a risk management plan for identified risks over the construction, operation and decommissioning phases of the project

8.0 Recommendations

While on the surface the design and implementation of a coastal setback may seem a relatively straight forward planning and management task, in reality many efforts to implement coastal setbacks have been overtaken by the complexities inherent in coastal environments, by conflicting values for coastal lands and resources, and by the pressures to promote tourism development in nearshore areas. Despite these complexities, the economic, environmental and social benefits of professional design and thoughtful implementation of setbacks will outweigh the short-term benefits of relatively un-controlled development in coastal areas.

It is becoming increasingly clear that to avoid loading unmanageable costs on future generations, coastal planning strategies for impacts such as sea level rise and severe weather are needed now (Tomlinson and Helman 2006; Simpson et al 2010). Within the countries of the Latin America and Caribbean Region, progress has been made over the last decade towards a more sustainable approach to the management of coastal development and coastal resources. However, faced with a changing climate, the continuing challenge to the sustainable management of coastal areas is finding a responsible balance among inaction, unreasonably expensive and premature action, and insightful pro-action that contributes not only to the sustainability of coastal environments, but also to the future well-being of coastal communities.

In order for knowledge on the development and application of coastal setbacks and other progressive coastal planning instruments to be effective and be consistent with the Cairo Principles (see Appendix E), there is a need to:

- work with local governments, organizations, and developers to design and implement thoughtful and defensible coastal setbacks to protect existing coastal environments, to reduce the costs of impacts to infrastructure and communities, and to protect human safety;
- incorporate setbacks in a suite of progressive planning instruments that support and expand upon the benefits of application, without creating undue or costly impacts to coastal development;
- institute, preserve and/or restore vegetation and other ecological easements and buffers that protect natural environments and reduce the need for costly artificial protection measures;
- work towards coastal retreat options as a preferred approach to development in high risk coastal areas, including the phase out of existing development ;
- apply zoning and no-build areas to protect sensitive ecosystems and cultural assets, and to prevent further construction in high-risk areas;
- employ market-based incentives to promote sustainable coastal tourism, including practices that level the field for all investors;
- in collaboration with the insurance industry, link the cost and coverage of property insurance with compliance to coastal planning objectives and to construction quality (as a cost recovery mechanism for superior design);
- improve public awareness of the costs and benefits of coastal planning, especially as it relates to adaptation to climate change; and
- assist implementation of coastal planning through support and capacity building for planning staff in all levels of government in the LAC region.

It is apparent that, as for many aspects of governance within countries in the Caribbean and Latin America, staff resources for coastal management are often limited, and the pressures to offer exceptions/variances to policies and instruments that curtail development can be significant and unavoidable. The development and effective application of coastal setbacks in the region therefore remains a challenge in many jurisdictions. While concerns for the impacts of climate change on coastal communities and environments in the LAC regions is visible and growing, integration of practical adaptation policies and instruments with local planning and decision-making still faces many challenges.

Given that the Inter-American Development Bank is the main source of multilateral financing and expertise for sustainable economic, social and institutional development in the Latin America and Caribbean Region, the Bank has a unique opportunity to provide leadership in supporting sustainable coastal development, in adaptation to climate change, and in fostering the positive contributions of the private sector to the well-being of coastal environments and coastal communities (IDB 2012). To assist the Region achieve greater economic and social progress, the Bank has a strong commitment to providing support for sustainable, climate-compatible development that:

- reduces poverty and social inequalities;
- addresses the needs of small and vulnerable countries;
- fosters development through the private sector;
- addresses climate change, renewable energy and environmental sustainability; and
- promotes regional cooperation and integration (IDB 2012).

Given that Bank investments in tourism and other coastal development projects have been on the rise, there is an internal need for instruments and tools that would more effectively inform Bank staff on critical issues, while supporting sustainable management of the environmental and social risks of the Bank's portfolio. Additionally, in many nations of the LAC region, there are insufficient planning tools to promote effective pro-action on either sustainable coastal development, or adaptation to impending climate change. Given the Bank's unique position in the region, and its capacity to provide needed leadership and support across countries and sectors, it is recommended that:

- the Bank develop and promote a policy statement on development in coastal areas, including the intent to proactively plan for changes in sea level rise and severe weather that are now associated with a changing climate;
- the Bank, in recognizing its leadership role in sustainable coastal development, require that all projects in coastal areas meet or exceed the planning objectives and the minimum

required coastal setbacks *(without application for exemptions* – so as to account for and provide a safety margin for sea level rise) as prescribed by the country in which the development takes place;

- when countries revise setback requirements to account for sea level rise and other impacts of climate change, the new climate change adapted setbacks shall become the standard for all new construction on the development property;
- where existing coastal planning policy or instruments do not exist or do not meet the Bank's stated policy on coastal development, applicants to the Bank must meet or exceed the objectives of the Bank's coastal policy (without application for exemptions), including the minimum coastal setbacks applicable to the development area (as established by an average of nearby countries or countries in the region with similar geophysical characteristics);
- within three years the Bank undertake a review of government, lending institutions, and private sector practices with respect to adaptation to sea level rise and coastal climate change and related changing liability of government regulators and lenders, and revises its policy to account for changing circumstances and best practice; and
- the Bank develop guidance and ultimately a detailed guide for coastal planning and for the development and application of coastal planning instruments (e.g. setbacks, zoning, codes, guidelines) similar to those being developed in other jurisdictions (see Appendix F for one example), and intended for use internally by Bank staff, and as an external guide for development proposals.

To assist the Bank in the development of a guidance document, its policy on coastal development planning and a ultimately a detailed guide on costal setbacks, it is recommended that the Bank sponsor a series of regional workshops in LAC on coastal planning and management policy in the context of advancing current practice and adaptation to climate change and sea level rise. In addition to a professional examination of the opportunities and constraints in application of coastal setbacks to proposed development, the workshops would provide an opportunity to disseminate the current state of knowledge on the implications of climate change and sea level rise for coastal management and planning. Attendees to the workshops would include professionals (e.g. planners, architects, engineers, landscape architects) and other decision-makers currently working in coastal management at all levels of governments within

LAC region countries; as well as active members of the scientific community, private sector developers and members of the planning and design communities, and decision-makers from the investment and insurance sector.

The outcome of the workshops would contribute to the development of guidance document, a refined IDB coastal development policy, as well as, ultimately a set of coastal development guidelines contained in a detailed guide, with special reference to planning and management tools such as setbacks, zoning, and emergency preparedness. Such collaborative effort could ensure that the development of a *Guideline for the Design and Implementation of Coastal Setbacks* would be a useful tool, not only for Bank staff, but also for the private sector and the professions, a step forward in promoting leadership in coastal development planning throughout the LAC region. The Guideline could provide pragmatic direction to developers, lenders and insurers to improve their proactive capacity to reduce the risks and liabilities for damage to property, and to ensure the sustainability and the quality of the coastal environments on which their industry depends. Such workshops and resulting policy and planning guidelines would also represent international leadership by the Bank, with important policy and planning development lessons for coastal communities throughout developing and emerging economies.

The opportunity for the IDB to take a leadership and collaborative role in advancing knowledge and implementation of a common policy and approach to coastal setbacks in the Region cannot be overstated. Given the Bank's investment in coastal development, and in the future economies of the LAC countries, it is prudent for the institution to protect its own resources, while ensuring a sustainable future for the nations it seeks to assist.

Appendix A: Glossary of Terms

This glossary is compiled from definitions provided in the Global Environmental Outlook GEO4 report of the United Nations (UNEP 2007), from the online glossary at the Australian government's OzCoasts website (http://www.ozcoasts.gov.au/glossary/def_a-b.jsp), from documents from the Government of South Africa (GOV/SAFR 2010) and from other sources (GOV/USA/EPA 2009, GOV/USA/NOAA 2012b, IOC 2009, IPCC 2007b, UN/ISDR 2004a).

A

Abundance
The number of individuals or related measure of quantity (such as biomass) in a population, community or spatial unit.

Access, lateral
the right to walk or otherwise move along a shoreline, once someone has reached the shore

Access, perpendicular
a legally permissible means of reaching the shore from dry land

Acidification
Change in environment's natural chemical balance caused by an increase in the concentration of acidic elements.

Acidity
A measure of how acid a solution may be. A solution with a pH of less than 7.0 is considered acidic.

Acceptable Risk
The level of loss a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions. In engineering terms, acceptable risk is also used to assess structural and non-structural measures undertaken to reduce possible damage at a level which does not harm people and property, according to codes or "accepted practice" based, among other issues, on a known probability of hazard.

Accretion
The deposition or addition of material to a sediment deposit or landform. In effect, the opposite of erosion.

Adaptive capacity
The potential or ability of a system, region or community to adapt to the effects or impacts of a particular set of changes. Enhancement of adaptive capacity represents a practical means of coping with changes and uncertainties, reducing vulnerabilities and promoting sustainable development.

Adaptive management
Adaptive management is a systematic process for continually improving management policies and practices by learning from new knowledge and from experience.

Advection
Advection is transport of substances in a fluid by the flow. An example of advection is the transport of pollutants in a river or the ocean by a current which carries these impurities along with it.

Aeolian
The erosion, transport, and deposition of material by wind, and work best when vegetation cover is sparse, or absent.

Algal beds
Reef top surface feature dominated by algae cover, usually brown algae (such as Sargassum or Turbinaria).

Algal blooms
A rapid increase in the abundance of phytoplankton or benthic algae in a given area.

Alongshore
Parallel to and near the shoreline.

Alkalinity
The total alkalinity of a water is the sum of the bases that are titratable with strong acid. In seawater alkalinity is roughly equal to the carbonate alkalinity plus borate. In most natural freshwaters total alkalinity is roughly equal to the carbonate alkalinity.

Anoxia
When dissolved oxygen concentrations are approximately zero.

Anoxic
The condition of oxygen deficiency or absence of oxygen. Anoxic sediments and anoxic bottom waters are commonly produced where there is a deficiency of oxygen due to very high organic productivity and a lack of oxygen replenishment to the water or sediment, as in the case of stagnation or stratification of the water body.

Anthropogenic
Originating from human activities.

Aquaculture
The farming of aquatic organisms in inland and coastal areas, involving intervention in the rearing process to enhance production and the individual or corporate ownership of the stock being cultivated.

Aquatic Biodiversity
Includes both marine and freshwater biodiversity including wetlands, bogs, marshes, groundwater, etc.

Aquatic ecosystem
Basic ecological unit composed of living and non-living elements interacting in an aqueous milieu.

Aquifer
An underground geological formation or group of formations, containing usable amounts of groundwater that can supply wells and springs.

Arable land
Land under temporary crops (double-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens, and land temporarily fallow (less than five years). The abandoned land resulting from shifting cultivation is not included in this category.

Aridity index
The long-term mean of the ratio of mean annual precipitation to mean annual potential evapotranspiration in a given area.

Armoring
The placement of fixed engineering structures, typically rock or concrete, on or along the shoreline to mitigate the effects of coastal erosion and protect infrastructure; such structures include seawalls, revetments, bulkheads, and riprap.

Asset
The attributes of a system that hold value for the community and about which the community would be concerned if they were lost or degraded.

B

Ballast water
Water carried by a vessel to improve its stability.

Bar
An offshore ridge or mound of sand, gravel, or other unconsolidated material which is submerged (at least at high tide), especially at the mouth of a river or estuary, or lying parallel to, and a short distance from, the beach.

Barrier island
A long, narrow coastal sandy island that is above high tide and parallel to the shore, and that commonly has dunes, vegetated zones, and swampy terraces extending landward from the beach.

Barrier island roll-over
The landward migration or landward transgression of a barrier island, accomplished primarily over decadal or longer time scales through the process of storm overwash, periodic inlet formation, and wind-blown transport of sand.

Barrier migration
The movement of an entire barrier island or barrier spit in response to sea-level rise, changes in sediment supply, storm surges or waves, or some combination of these factors.

Barrier spit
A barrier island that is connected at one end to the mainland.

Bathymetry
The measurement of depths of water in oceans, seas and lakes; also the information derived from such measurements.

Bay
A recess or inlet in the shore of a sea or lake between two capes or headlands, not as large as a gulf but larger than a cove.

Beach
(1) a deposit of non-cohesive material (e.g. sand, gravel) situated on the interface between dry land and the sea (or other large expanse of water) and actively worked by present-day hydrodynamic processes (i.e. waves, tides and currents) and sometimes by winds. (2) the zone of unconsolidated material that extends landward from the low water line to the place where there is marked change in material or physiographic form, or to the line of permanent vegetation. The seaward limit of a beach, unless otherwise specified, is the mean low water line. A beach includes foreshore and backshore. (3) the zone of unconsolidated material that is moved by waves, wind and tidal currents, extending landward to the coastline.

Beach erosion
The carrying away of beach materials by wave action, tidal currents, littoral currents or wind.

Beach face/foreshore
The part of a beach that is usually exposed to the uprush of waves.

Beach nourishment
The addition of sand, often dredged from offshore, to an eroding shoreline to enlarge or create a beach area, offering both temporary shore protection and recreational opportunities.

Beach profile
A cross-section taken perpendicular to a given beach contour; the profile may include the face of a dune or seawall, extend over the backshore, across the foreshore, and seaward underwater into the nearshore zone.

Bed
The bottom of a watercourse, or any body of water.

Bedload
Sedimentary material subject to transport by flowing water (e.g. currents) which is moved by rolling, pushing, and saltation. The size of particles moved is proportional to the strength of water movement.

Benchmark
A reference point or standard against which performance or achievements can be compared.

Benefits
The economic value of a scheme, usually measured in terms of the cost of damages avoided by the scheme, or the valuation of perceived amenity or environmental improvements.

Benthic
Pertaining to the seafloor (or bottom) of a lake, river, coastal waterway, or ocean.

Benthic invertebrates
Organisms that live on the bottom of a water body (or in the sediment) and have no backbone.

Benthos
Collective synonym for benthic organisms, but frequently also applied to the floor or deepest part of a sea or ocean.

Best practice
Used to describe a technique, method, process, or activity that is more effective at delivering a particular outcome than any other technique, method, process or activity. Also defined as the most efficient (least amount of effort) and effective (best results) method to accomplish a task.

Bioaccumulation
The increase in concentration of a chemical in organisms that reside in contaminated environments.

Bioavailability
The degree to which a contaminant or nutrient in an environmental media can be absorbed, transported, and utilised physiologically.

Biocapacity
The capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and extraction technologies.

Biochemical oxygen demand (BOD)
The amount of dissolved oxygen, in milligrams per litre, necessary for the decomposition of organic matter by micro-organisms, such as bacteria. Measurement of BOD is used to determine the level of organic pollution of a stream or lake. The greater the BOD, the greater the degree of water pollution.

Biodiversity (a contraction of biological diversity)
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.

Biodiversity indicators
Indicators or measures that allow us to determine the degree of biological or environmental changes within ecosystems, populations or groups of organisms over time and space.

Biological resources
Genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.

Biomass
The dry weight of all organic matter contained within plants, animals or micro-organisms per unit of habitat.

Biotoxins
Naturally occurring toxic compounds produced by certain organisms.

Bioturbation
Organisms, mainly worms or crustaceans, that disturb the sediment by burrowing or during feeding. Their activities mix the sediment layers and may cause substantial sediment resuspension.

Blue water
Surface water and groundwater that is available for irrigation, urban and industrial use and environmental flows.

Bluff
A high bank or bold headland with a broad, precipitous, sometimes rounded cliff face overlooking a plain or body of water.

Breakwater
An offshore structure (such as a wall or jetty) that, by breaking the force of the waves, protects a harbor, anchorage, beach or shore area.

Buffer area
A parcel or strip of land that is designed and designated to permanently remain vegetated in an undisturbed and natural condition to protect an adjacent aquatic or wetland site from upland impacts, to provide habitat for wildlife and to afford limited public access.

Building codes
Ordinances and regulations controlling the design, construction, materials, alteration and occupancy of any structure to insure human safety and welfare. Building codes include both technical and functional standards.

By-catch
All living and non-living material which is caught incidentally while fishing for a target species.

C

Canopy cover (also called crown closure or crown cover)
The percentage of the ground covered by a vertical projection of the outermost perimeter of the natural spread of the foliage of plants. Cannot exceed 100 per cent.

Capacity
The ability of individuals and organisations to undertake activities and projects effectively, efficiently and in a sustainable manner.

Capacity building
Enhancing the ability of individuals, groups and organisations to effectively, efficiently and in a sustainable manner achieve outcomes.

Capital
Resource that can be mobilized in the pursuit of an individual's goals. Thus, we can think of natural capital (natural resources such as land and water), physical capital (technology and artefacts), social capital (social relationships, networks and ties), financial capital (money in a bank, loans and credit), human capital (education and skills).

Carbon sequestration
The process of increasing the carbon content of a reservoir other than the atmosphere.

Catchment (area)
The area of land bounded by watersheds draining into a river, basin or reservoir.

Causal relationship
A logical connection or cause-and-effect linkage existing in the achievement of related, interdependent results. Generally the term refers to plausible linkages, not statistically accurate relationships.

Cay
A small, low island composed largely of coral or sand.

Characteristic
A property of the ecosystem, separate from our measurement of it. For instance, recruitment is a characteristic of a fish population.

Channels
Environments of frequently high energy, in terms of tidal movement (e.g. tidal channels) or fluvial flow (e.g. river channels).

Chlorophyll a
A green pigment found in plants. Chlorophyll a concentrations are an indicator of phytoplankton abundance and biomass in coastal and estuarine waters.

Clean technology (also environmentally sound technology)
Manufacturing process or product technology that reduces pollution or waste, energy use or material use in comparison to the technology that it replaces.

Cliff
A high steep face of rock.

Climate variability
Variations in the mean state and other statistics (such as standard deviations and the occurrence of extremes) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes in the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability).

Coarse sediment
A sediment comprising coarse-grained material such as sand or gravel particles.

Coastal area
An entity of land and water affected by the biological and physical processes of both the sea and land and defined broadly for the purpose of managing the use of natural resources.

Coastal foreshore reserve
The area of land on the coast set aside in public ownership to allow for coastal processes and provide protection of ecological values, landscape, visual amenity, indigenous and cultural heritage, and public access, recreation and safety.

Coastal processes
Collective term covering the action of natural forces on the shoreline and the nearshore seabed.

Coastline
(1) technically, the line that forms the boundary between the coast and the shore. (2) commonly, the line that forms the boundary between land and the water. (3) the line where terrestrial processes give way to marine processes, tidal currents, wind waves, etc.

Collaboration
An approach to planning and decision-making aimed at improving relationships and seeking resolutions that meet the needs and interests of all parties to the greatest possible degree.

Co-management
A management approach in which responsibility for resource management is shared between the government and resource user groups.

Component
Broad features of the immediately preceding category (e.g. biodiversity, productivity and physical/chemical features would be components of an ecosystem).

Conservation
The maintenance of sustainable use of the Earth's resources in a manner that maintains ecosystem, species and genetic diversity and the evolutionary and other processes that shaped them. Conservation may or may not involve the use of resources; that is, certain areas, species or populations may be excluded from human use as part of an overall landscape/waterscape conservation approach.

Conservation tillage
Breaking the soil surface without turning over the soil.

Condition (state)
The state or health of individual animals or plants, communities or ecosystems.

Contaminant
Chemical (toxicants) and biological (i.e. bacterial and viral pathogens) constituents of the environment capable of producing adverse effects on biological systems.

Contamination
An anthropogenic increase in the concentration of a substance that does not normally occur in an environment, that normally occurs at significantly lower concentrations, and/or that can adversely affect the environment.

Continental shelf
The zone bordering a continent extending from the line of permanent immersion to the depth, usually about 100 m to 200 m, where there is a marked or rather steep descent toward the great depths.

Contour line
A line connecting points, on a land surface or sea bottom, which have equal elevation. It is called an isobath when connecting points of equal depth below a datum.

Coping capacity
The means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a coastal disaster.

Corridors
Measures that are taken to ensure the natural immigration and emigration of populations and species. This may be a physical corridor, such as a terrestrial or marine migration route, a flyway, or it may refer to a particular management practice that allows species and populations to continue patterns of movement.

Coral bleaching
The paling or whitening of corals due to a loss or decline of the symbiotic microalgae that live within the coral polyp, and that give it colour. Coral bleaching is caused by both natural and human-induced variations in the reef environment. Some causes of coral bleaching include

changes in water temperature, sub-aerial exposure caused by low tides or changes in sea level and rapid dilution of salinity levels.

Cost-benefit analysis
A technique designed to determine the feasibility of a project or plan by quantifying its costs and benefits.

Cross-cutting issue
An issue that cannot be adequately understood or explained without reference to the interactions of several dimensions that are usually treated separately for policy purposes. For example, in some environmental problems economic, social, cultural and political dimensions interact with one another to define the ways and means through which society interacts with nature, and the consequences of these interactions for both.

Cross-shore
Perpendicular to the shoreline.

Cultural services
The non-material benefits people obtain from ecosystems, including spiritual enrichment, cognitive development, recreation and aesthetic experience.

Culturally sensitive
Any traditional or cultural issue that in accordance with traditional laws and customs, including as advised by aboriginal elders, can be considered to be sensitive, or of a sacred nature.

Current
The horizontal movement patterns in bodies of water; in coastal areas, currents are influenced by a combination of tidal (flood and ebb) and non-tidal (wind-driven, river flow) forces.

D

Dead zone
A part of a water body so low in oxygen that normal life cannot survive. The low oxygen conditions usually result from eutrophication caused by fertilizer run-off from land.

Debris line
A line near the limit of storm wave up-rush marking the landward limit of debris deposits.

Decomposition of organic matter
A process (variously referred to as oxidation, metabolism, degradation and mineralisation) by which organic matter is first oxidised by molecular oxygen, and the products (or metabolites) of the reaction are carbon dioxide and recycled nutrients (i.e. the reaction is the reverse of photosynthesis)

Deep water
In regard to waves, where depth is greater than one-half the wave length. Deep-water conditions are said to exist when the surf waves are not affected by conditions on the bottom.

Deforestation
Conversion of forested land to non-forest areas.

Demersal fish
Bottom foraging fish that normally live near or on the seabed.

Delta
A low relief landform composed of sediments deposited at the mouth of a river that commonly forms a triangular or fan shaped plain of considerable area crossed by many channels from the main river; forms as the result of accumulation of sediment supplied by the river in such quantity that it is not removed by tidal or wave-driven currents.

Deposition
The dropping of material which has been picked up and transported by wind, water, or other processes.

Depth
Vertical distance from still-water level (or datum as specified) to the bottom.

Depuration
The process of placing harvested shellfish in containers that contain clean estuarine water, where it is intended that they will purge themselves of their gastrointestinal contents. The effectiveness of depuration can vary with salinity, temperature and turbidity.

Design storm
Coastal protection structures will often be designed to withstand wave attack by the extreme design storm. The severity of the storm (i.e. return period) is chosen in view of the acceptable level of risk of damage or failure. A design storm consists of a design wave condition, a design water level and a duration.

Design wave
In the design of harbours, harbour works, etc., the type or types of waves selected as having the characteristics against which protection is desired.

Dike
A wall generally of earthen materials designed to prevent the permanent submergence of lands below sea level, tidal flooding of lands between sea level and spring high water, or storm-surge flooding of the coastal floodplain.

Direction of waves
Direction from which waves are coming.

Direction of wind
Direction from which wind is blowing.

Disaster
A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.

Disaster risk management
The systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters.

Disaster risk reduction
The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development.

Dissolved oxygen
The amount of oxygen contained in water that defines the living conditions for oxygen-requiring (aerobic) aquatic organisms.

Drainage basin (also called watershed, river basin or catchment)
Land area where precipitation runs off into streams, rivers, lakes and reservoirs. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge.

Dunes
As with beaches, coastal dunes begin with the accumulation of marine sand that is transported to the coast by waves and currents. However, the sand is subsequently reworked by strong onshore winds (greater than 5 m/sec) and then deposited behind the beach.

Dune vegetation
Communities of plants that grow on beaches and dunes are known as dune vegetation.

E

Early warning
The provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare an effective response.

Ebb Tide
A falling tide - the phase of the tide between high water and the succeeding low water.

Ecological sustainability
The use of components of biological diversity in a way and at a rate that it does not lead to long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

Ecology
The branch of science studying the interactions among living things and their environment.

Ecosystem
A complex set of relationships of living organisms functioning as a unit and interacting with their physical environment. The boundaries of what could be called an ecosystem are somewhat arbitrary, depending on the focus of interest or study.

Ecosystem integrity
The capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having species composition, diversity, and functional organisation comparable to that of natural habitats of the region.

Ecosystem assessment
A social process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-being, and management and policy options are used to advise decision-makers.

Ecosystem function
An intrinsic ecosystem characteristic related to the set of conditions and processes whereby an ecosystem maintains its integrity (such as primary productivity, food chain and biogeochemical cycles). Ecosystem functions include such processes as decomposition, production, nutrient cycling, and fluxes of nutrients and energy.

Ecotourism
Tourism that is based on environmentally responsible travel and visitation to relatively undisturbed natural areas.

Effect
An intended or unintended change resulting directly or indirectly from an intervention.

Effectiveness
A measure of the extent to which a program, project or initiative has attained, or is expected to attain, its relevant objectives efficiently and in a sustainable way.

Efficiency
The notion of getting the highest value out of program or project resources.

Effluent
In issues of water quality, refers to liquid waste (treated or untreated) discharged to the environment from sources such as industrial process and sewage treatment plants.

El Niño -Southern Oscillation (ENSO)
A complex interaction of the tropical Pacific Ocean and the global atmosphere that results in irregularly occurring episodes of changed ocean and weather patterns in many parts of the world, often with significant impacts, such as altered marine habitats, rainfall changes, floods, droughts, and changes in storm patterns. The El Niño part of ENSO refers to the well-above average ocean temperatures along the coasts of Ecuador, Peru and northern Chile approximately the opposite condition to El Niño. Each El Niño or La Niña episode usually lasts for several seasons.

Embayment
A coastal indentation (or bedrock valley) which has been submerged by rising sea level, and has not been significantly infilled by sediment.

Emergency management
The organization and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation. (UN/ISDR 2004)

Enclosed sea
A sea in which 95% or more of the periphery is occupied by land.

Endangered species
Species that are threatened with immediate extinction or extirpation if the factors threatening them continue to operate. Included are species whose numbers have been reduced to a critical

level or whose habitats have been so drastically reduced that they are deemed to be in immediate danger of extinction.

Endemic species
Species native to, and restricted to, a particular geographical region.

End-of-pipe technology
Technology to capture or to transform emissions after they have formed without changing the production process. This includes scrubbers on smokestacks, catalytic converters on automobile tailpipes and wastewater treatment.

Energy efficiency
Using less energy to achieve the same output or goal.

Environmental assessment (EA)
An environmental assessment is the entire process of undertaking a critical and objective evaluation and analysis of information designed to support decision making. It applies the judgment of experts to existing knowledge to provide scientifically credible answers to policy relevant questions, quantifying where possible the level of confidence. It reduces complexity but adds value by summarizing, synthesizing and building scenarios, and identifies consensus by sorting out what is known and widely accepted from what is not known or not agreed. It sensitizes the scientific community to policy needs and the policy community to the scientific basis for action.

Environmental impact assessment (EIA)
An environmental impact assessment (EIA) is an analytical process or procedure that systematically examines the possible environmental consequences of the implementation of a given activity (project). The aim is to ensure that the environmental implications of decisions related to a given activity are taken into account before the decisions are made.

Environmental management framework
A management approach which includes organizational structure, responsibilities , planning activities, practices, procedures, resources and processes for developing, implementing, achieving, reviewing and maintaining a management goal.

Environmental policy
A policy initiative aimed at addressing environmental problems and challenges.

Environmental problems
Environmental problems are human and/or natural influences on ecosystems that lead to a constraint, cutback or even a cessation of their functioning.

Environmental Values
Environmental Values are values or uses of a system that we wish to protect. They outline values and beneficial uses of the environment that are important for healthy ecosystems, public benefit, industry and health that require protection from the effects of pollution and waste discharges.

Epidemiology
The study of the factors that influence the frequency and distribution of diseases.

Epifauna
Animals that live on the sediment but do not burrow into it.

Equity
Fairness of rights, distribution and access.

Erosion
Wearing away of the land by the action of natural forces. On a beach, the carrying away of beach material by wave action, tidal currents or by deflation.

Estuary
(1) a semi-enclosed coastal body of water which has a free connection with the open sea. The seawater is usually measurably diluted with freshwater. (2) the part of the river that is affected by tides.

Euryhaline
Organisms able to tolerate a wide range of salinity.

Eutrophication
A process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to: increased growth, primary production and biomass of algae; changes in the balance of organisms; and water quality degradation.

Evaluation
A periodic assessment of the impact, appropriateness, effectiveness, efficiency and legacy of a policy, program or project through a set of applied research techniques to generate systematic information that can help improve performance.

Evapotranspiration
Combined loss of water by evaporation from the soil or surface water, and transpiration from plants and animals.

Exposure
Elements at risk, an inventory of those people or artefacts that are exposed to a hazard.

External cost
A cost that is not included in the market price of the goods-and-services being produced. In other words, a cost not borne by those who create it, such as the cost of cleaning up contamination caused by discharge of pollution into the environment.

Ex situ conservation
The conservation of components of biological diversity outside their natural habitats, often in such institutions as zoos, museums, botanical gardens, aquariums and gene banks.

F

Fetch
The length of unobstructed open sea surface across which the wind can generate waves.

Fetch length
(1) the horizontal distance (in the direction of the wind) over which a wind generates seas or creates wind setup. (2) the horizontal distance along open water over which the wind blows and generates waves.

Fine Sediment
A sediment comprising fine-grained material such as mud or clay particles.

Flocculation
Flocculation in coastal waterways is a process in which particles of clay and organic matter stick together, through chemical interactions with divalent calcium and magnesium ions, to form larger flake-like particles (flocs or floccules) that may come out of solution. Flocculation influences the transport of fine-grained sediment, and enhances its deposition rate. Because particles belonging to various size classes can form flocs, the sediment that is deposited is often poorly sorted.

Flooding
The temporary submergence of land that is normally dry, often due to periodic events such as storms, see also *inundation*.

Flood tide
A rising tide - the phase of the tide between low water and the next high tide.

Flood proofing
Protecting structures from damage by flood waters. Dry flood proofing seals a structure such that floodwaters cannot get inside. Wet Flood proofing modifies a structure to allow floodwaters inside, but ensures that there is minimal damage to the building's structure and to its contents.

Flushing
Exchange of water between an estuary or coastal waterway and the ocean.

Fluvial
Pertaining to a river or freshwater source.

Food webs
Networks of feeding interactions between consumers and their food. The species composition of food webs varies according to habitat and region, but the principles of energy transfer from sunlight and plants through successive trophic levels are the same.

Forecast
Definite statement or statistical estimate of the occurrence of a future event.

Forest
Land spanning more than 0.5 hectares with trees higher than 5 metres and a canopy cover of more than 10 per cent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.

Forest degradation
Changes within the forest that negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or services.

Forest management
The processes of planning and implementing practices for the stewardship and use of forests and other wooded land aimed at achieving specific environmental, economic, social and/or cultural objectives.

Forest plantation
Forest stands established by planting and/or seeding in the process of afforestation or reforestation. They are either of introduced species (all planted stands), or intensively managed stands of indigenous species, which meet all the following criteria: one or two species at plantation, even age class and regular spacing.

Fossil fuel
Coal, natural gas and petroleum products (such as oil) formed from the decayed bodies of animals and plants that died millions of years ago.

Freshets
Increased freshwater flow following a recent rain, or artificial floods intended to benefit the aquatic environment (particularly fisheries) in which the discharge is over and above the basic compensation flow.

Freshwater
Water, typically derived from inland or rainfall, with less than 0.03% ionic content.

G

Gabion
Steel wire-mesh basket to hold stones or crushed rock to protect a bank or bottom from erosion.

Genetic diversity
The variety of genes within a particular species, variety or breed.

Genetic resources
Genetic material of actual or potential value.

Geographic information system (GIS)
A computerized system organizing data sets through a geographical referencing of all data included in its collections.

Geomorphology
The study of the nature and history of landforms and the processes which create them.

Georeferencing
(1) The process of scaling, rotating, translating and de-skewing the image to match a particular size and position (2) establishing the location of an image in terms of map projections or coordinate systems High water (HW): maximum height reached by a rising tide. The height may be solely due to the periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions. Non-technically, also called the high tide.

Global Environment Facility (GEF)
A financial mechanism that provides grant and concessional funds to developing countries for projects and activities that aim to protect the global environment. It is jointly implemented by the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP) and the World Bank.

Global (international) environmental governance
The assemblage of laws and institutions that regulate society-nature interactions and shape environmental outcomes.

Global sea-level rise
The worldwide average rise in mean sea level; may be due to a number of different causes, such as the thermal expansion of sea water and the addition of water to the oceans from the melting of glaciers, ice caps, and ice sheets; contrast with relative sea-level rise.

Global warming
Changes in the surface air temperature, referred to as the global temperature, brought about by the enhanced greenhouse effect, which is induced by emission of greenhouse gases into the air.

Globalization
The increasing integration of economies and societies around the world, particularly through trade and financial flows, and the transfer of culture and technology.

Goal
The higher-order objective to which a program is intended to contribute.

Governance
The manner in which society exercises control over resources. It denotes the mechanisms through which control over resources is defined and access is regulated. Governance is exercised through institutions: laws, property rights systems and forms of social organization.

Green procurement
Taking environmental aspects into consideration in public and institutional procurement.

Green tax
Tax with a potentially positive environmental impact. It includes energy taxes, transport taxes, and taxes on pollution and resources. They are also called environmental taxes. Green taxes are meant to reduce environmental burden by increasing prices, and by shifting the basis of taxation from labour and capital to energy and natural resources.

Green water
That fraction of rainfall that is stored in the soil and is available for the growth of plants.

Greenhouse effect
Greenhouse gases possess high emissivity at specific infrared wavelengths. Atmospheric infrared radiation is emitted to all sides by those greenhouse gases, including downward to the Earth's surface. Thus greenhouse gases add more heat within the surfacetroposphere system, leading to an increase of the temperature. Atmospheric radiation is strongly coupled to the temperature of the level at which it is emitted. In the troposphere the temperature generally decreases with height. Effectively, infrared radiation emitted to space originates from an altitude with a temperature of, on average, -19°C, in balance with the net incoming solar radiation, whereas the Earth's surface is kept at a much higher temperature of, on average, +14°C. An increase in the concentration of greenhouse gases leads to an increased infrared opacity of the atmosphere, and therefore to an effective radiation into space from a higher altitude at a lower temperature. This causes a radiative forcing, an imbalance that can only be compensated for by an increase of the temperature of the surface-troposphere system. This is the enhanced greenhouse effect.

Greenhouse gases (GHGs)
Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. There are human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine and bromine containing substances. Beside CO_2, N_2O and CH_4, the Kyoto Protocol deals with sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Grey water
Wastewater other than sewage, such as sink drainage or washing machine discharge.

Groundwater
Water that flows or seeps downward and saturates soil or rock, supplying springs and wells. The upper surface of the saturate zone is called the water table.

Gully Erosion
A gully is a narrow channel eroded into a hill-slope when surface water flow increases in response to clearing and overuse of the land. Other factors that play a role in gully initiation are the type of land use, geology, rainfall, soil texture, slope, hill-slope length and seasonal climatic extremes. Gully erosion is a major land degradation process. Erosion from gullies and streambanks removes valuable soil and can generate as much as 90% of the sediment yield from a catchment. The sediment is a major source of turbidity and particulate nutrients in some rivers and coastal waterways.

H

Habitat
The place or type of site where an organism or population naturally occurs. Terrestrial or aquatic areas distinguished by geographic, abiotic and biotic features, whether entirely natural or semi-natural.

Habitat, geomorphic

Halophytic
Salt-tolerant vegetation.

Harmful alien organisms
Organisms that enter an ecosystem in which they are not naturally known to exist, through deliberate or inadvertent actions by humans, and thereby pose a threat to native species.

Hazard
A potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Hazardous waste
By-products of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Substances classified as hazardous wastes possess at

least one of four characteristics: ignitability, corrosivity, reactivity or toxicity, or appear on special lists.

Headward
The landward or upstream section of an estuary or coastal waterway

Heavy metals
A group name for the block of metals belonging to Groups 3 to 16 of the periodic table, in periods of 4 or greater. Heavy metals include metals and semimetals (metalloids), such as arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc, that have been associated with contamination and potential toxicity.

High seas
The oceans outside of national jurisdictions, lying beyond each nation's exclusive economic zone or other territorial waters.

High water mark
A reference mark on a structure or natural object, indicating the maximum stage of tide or flood.

Human health
A state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity.

Human well-being
The extent to which individuals have the ability to live the kinds of lives they have reason to value; the opportunities people have to achieve their aspirations. Basic components of human well-being include: security, material needs, health and social relations.

Hydrological cycle
Succession of stages undergone by water in its passage from the atmosphere to the earth and its return to the atmosphere. The stages include evaporation from land, sea or inland water, condensation to form clouds, precipitation, accumulation in the soil or in water bodies, and re-evaporation.

Hypersaline
Water with a high concentration of salt, e.g. greater than the ionic content of seawater.

Hypertidal
Coastal areas with a high mean tidal range, e.g. equal to or greater than 6 metres.

Hypoxia
Hypoxia occurs when dissolved oxygen concentrations are < 2.0 mg L-1.

I

Impoundments
Impoundments include dams, locks, weirs, reservoirs and farm dams. The regulation of rivers through the construction of these structures has changed natural flow regimes and altered environmental flows.

Income poverty
A measure of deprivation of well-being focusing solely on per capita or household income.

Indicator

A quantitative or qualitative measure that provides information about the status of or changes in natural, cultural, and economic aspects of an ecosystem.

Indigenous
Includes a community council, council of elders, registered native title body

Indigenous Vegetation
Indigenous vegetation consists of plant species that existed in a given state prior to European arrival.

Infauna
Animals that live within the sediment.

Inlet
A small, narrow opening, recess, indentation, or other entrance into a coastline or shore of a lake or river through which water penetrates landward; commonly refers to a waterway between two barrier islands that connects the sea and a lagoon.

Inorganic contaminants
Mineral-based compounds, such as metals, nitrates and asbestos, that naturally occur in some parts of the environment, but can also enter the environment as a result of human activities.

In situ conditions
Conditions where genetic resources exist within ecosystems and natural habitats, and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

In situ conservation
The conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive characteristics.

Institutions
Regularized patterns of interaction by which society organizes itself: the rules, practices and conventions that structure human interaction.

Integrated management
An ongoing and collaborative planning process, involving stakeholders and regulators, that seeks to reach agreement on the best mix of conservation, sustainable use and economic development for the benefit of all.

Integrated pest management (IPM)
A holistic or integrated approach to controlling the risks and damage associated with natural predators, diseases and pests. It involves using site-specific information to determine the most effective combination of physical, chemical, biological, or cultural practices to reduce damage, while reducing impacts on the environment, biological diversity and human health.

Integrated coastal management (ICM)
The management of sectoral components of a coastal area (e.g. fisheries, forestry, agriculture, tourism, urban development) as part of a functional whole.

Integrated ecosystem monitoring
The intermittent (regular or irregular) surveillance to ascertain the extent of compliance with a predetermined standard or the degree of deviation from an expected norm.

Integrated water resources management (IWRM)
A process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems

Intellectual property
Includes all copyright, all rights in relation to inventions (including patent rights), plant varieties, registered and unregistered trademarks (including service marks), registered designs and circuit layouts, and all other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields, as well as traditional Indigenous knowledge.

Intertidal zone
The part of the shoreline that is submerged at high tide and exposed at low tide.

Intertidal mud flats
Intertidal mud flats are un-vegetated, generally low gradient and low energy environments that are subject to regular tidal inundation, and that consist of poorly- to moderately-sorted sandy mud and muddy sand.

Intrinsic value
The value of someone or something in and for itself, irrespective of its utility for people.

Introduced species
Introduced species (exotic, invasive or alien species) are species moved to locations outside their natural range by human-mediated dispersal.

Inundation
The submergence of land by water, particularly in a coastal setting.

Inundation line
The line marking the maximum horizontal inland penetration of a tsunami, storm surge or other coastal flood hazard from the shoreline.

Invasive alien species
An alien species whose establishment and spread modifies ecosystems, habitats or species.

K

Kills
A kill is an unexpected and generally short-lived event marked by the conspicuous death of large numbers of organisms.

L

Landscapes
Complexes of ecosystems in geographically defined areas.

Lagoon

A shallow coastal body of seawater that is separated from the open ocean by a barrier or coral reef; the term is commonly used to define the shore-parallel body of water behind a barrier island or barrier spit.

La Niña
A cooling of the ocean surface off the western coast of South America, occurring periodically every 4-12 years and affecting Pacific and other weather patterns.

Land cover
The physical coverage of land, usually expressed in terms of vegetation cover or lack of it. Influenced by but not synonymous with land use.

Land degradation
The loss of biological or economic productivity and complexity in croplands, pastures and woodlands. It is due mainly to climate variability and unsustainable human activity.

Land use
The human use of land for a certain purpose. Influenced by, but not synonymous with, land cover.

Legacy
The enduring consequences of past investments, policies or actions that can be captured and/or bequeathed.

Legitimacy
Measure of the political acceptability or perceived fairness. State law has its legitimacy in the state; local law and practices work on a system of social sanction, in that they derive their legitimacy from a system of social organization and relationships.

Levee
Raised embankment of a river, showing a gentle slope away from the channel. It results from periodic overbank flooding, when coarser sediment is immediately deposited due to a reduction in velocity.

Lifespan
The lifespan of a coastal waterway is the length of time available before estuarine habitats are lost (e.g. central basin and intertidal areas) due to infilling, and only deltaic habitats remain (mainly channels and swamp areas).

Littoral zone
The intertidal area and the infralittoral zone, extending from the highest water spring tide down to the lower limits for macrophytic growth, an approximate 1% light level.

Low water mark
Low water mark is a term generally used to describe the low tide line.

M

Macroalgae
An ancient class of large multicellular plants (seaweeds) that resemble vascular plants but lack the complex array of tissues used for reproduction and water transport.

Macrotidal

Coastal ocean or waterway with a high mean tidal range, e.g. greater than 4 metres.

Mainstreaming
The consideration of environmental issues in the design of policies for development.

Management unit
The geographical area under consideration for the purposes of risk assessment and mitigation. This may be national in scale, or at the district or local levels.

Marginal sea
A sea situated between island and continent; seas located along margins of continents and having wide connections with the open sea.

Marine environmental quality (MEQ)
The status and trends observed in physical, chemical and biological conditions within the marine environment.

Marine pests
Introduced species that threaten human health or environmental and economic values.

Marine protected area (MPA)
A geographically defined marine area that is designated or regulated and managed to achieve specific conservation objectives.

Marsh
A frequently or continually inundated wetland characterized by herbaceous vegetation adapted to saturated soil conditions (see also salt marsh).

Mean high water springs (MHWS)
The average height of the high water occurring at the time of spring tides.

Mean sea level
The average relative sea level over a period, such as a month or a year, long enough to average out transients such as waves and tides.

Meta-analyses
Procedures looking for overall effects or how variation in the strength of effects in individual studies can be accounted for by specific broad-scale factors.

Micro-organism
Any organism that can be seen only with the aid of a microscope.

Mitigation
Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.

Monitoring
The regular collection and analysis of information to assist timely decision making, ensure accountability and provide the basis for evaluation and learning.

Mouth
The entrance of the coastal waterway, or the place where the sea meets or enters the coastal waterway.

Native vegetation
Vegetation that is indigenous to a given state, including trees, shrubs, understory plants and some specified grasslands.

Natural capital
Natural assets in their role of providing natural resource inputs and environmental services for economic production. Natural capital includes land, minerals and fossil fuels, solar energy, water, living organisms, and the services provided by the interactions of all these elements in ecological systems.

Natural hazards
Natural processes or phenomena occurring in the biosphere that may constitute a damaging event. Natural hazards can be classified by origin namely: geological, hydro-meteorological or biological. Hazardous events can vary in magnitude or intensity, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing.

Naturalness
The way a system would have functioned in the absence of human impacts.

Natural resources accounting
Accounting for the state and quality of the environment and the natural resource base by deducting from the gross domestic product various aspects of environmental degradation, such as the value of pollution abatement and control expenditures, the cost of environmental damage, and the depletion of natural resources.

Non-indigenous species (also, alien, exotic, foreign, non-native)
A species that has been transported by human activity, intentionally or accidentally, into a region where it does not occur naturally

Natural resource management
Any activity relating to managing the use, development or conservation of one or more of the following: soil, water, vegetation and biodiversity, including coastal and marine areas and natural values of nationally listed heritage places.

Nautical mile
A unit of distance equal to 1,852 metres

Neap tide
Tide smaller than the mean tidal range.

Near-pristine estuaries
Estuaries that have not been impacted upon by humans in significant ways, and are considered to exist in an essentially natural state. This means that the estuaries are not used for aquaculture, that fishing is limited and sustainable and that the water movements through the estuaries and fringing wetlands have not been altered by roads or engineered structures. Catchments of near-pristine estuaries retain most of their natural vegetation cover, and experience sediment and nutrient loading near the levels they would have been if European-style living and farming practices had never been introduced.

Nearshore receiving environment
The marine or estuarine waters into which rivers empty

Non-governmental organization (NGO)
An organization, usually non-profit, that is not part of the central, local, or municipal government.

Non-point source of pollution (diffuse source)
Multiple, not easily identifiable, non-discrete sources of pollution, without a single point of origin or not introduced into a receiving stream from a specific outlet. Common non-point sources are agriculture, forestry, city streets, mining, construction, dams, channels, land disposal and landfills, and saltwater intrusion.

Non-point Sources
A source of sediment or nutrients that is not restricted to one discharge location.

Non-renewable resources
Resources such as minerals, metals, natural gas and oil, whose reserves are depleted by their use. Pest Control Products - classes of substances that are generally referred to as insecticides, pesticides, herbicides, fungicides, germicides, nematicides, bactericides, viricides and are either of a chemical or biological nature.

Non-structural measures
Policies, regulations and plans that promote good coastal hazard management practices to minimize coastal hazards risks.

Nutrient enrichment (nutrification)
The effect of adding large quantities of organic and inorganic nutrients to the environment

Nutrient loading
Quantity of nutrients entering an ecosystem in a given period of time.

Nutrient pollution
Contamination of water resources by excessive inputs of nutrients.

Nutrients
The approximately 20 chemical elements known to be essential for the growth of living organisms, including nitrogen, sulphur, phosphorous and carbon, as well as metals, such as copper, zinc and chromium, when present at low concentrations (micronutrients).

O

Ocean Acidification
Ocean acidification is the reduction of the pH of the world's oceans due to higher CO2 concentrations in the atmosphere.

Offshore
(1) In beach terminology, the comparatively flat zone of variable width, extending from the shore face to the edge of the continental shelf. It is continually submerged. (2) the direction seaward from the shore. (3) the zone beyond the nearshore zone where sediment motion induced by waves alone effectively ceases and where the influence of the sea bed on wave action is small in comparison with the effect of wind. (4) the breaker zone directly seaward of the low tide line.

Offshore wind
A wind blowing seaward from the land in the coastal area.

Organic Material
Once-living material (typically with high carbon content), mostly of plant origin.

Organizations
Bodies of individuals with a specified common objective

Overexploitation
The excessive use of raw materials without considering the long-term ecological impacts of such use.

Overwash
The sediment that is transported from the beach across a barrier and is deposited in an apron-like accumulation along the backside of the barrier; overwash usually occurs during storms when waves break through the frontal dune ridge and flow landward toward the marsh or lagoon.

Outcrop
A surface exposure of bare rock, not covered by soil or vegetation.

Overtopping
Water carried over the top of a coastal defence due to wave run-up or surge action exceeding the crest height.

P

Participatory approach
Securing an adequate and equal opportunity for people to place questions on the agenda and to express their preferences about the final outcome during decision making to all group members. Participation can occur directly or through legitimate representatives. Participation may range from consultation to the obligation of achieving a consensus.

Pathogen
A causative agent of disease. Microbial pathogens are microscopic organisms including bacteria, viruses, protozoa and fungi.

Payment for environmental services
Appropriate mechanisms for matching the demand for environmental services with the incentives of land users whose actions modify the supply of those environmental services.

Peak period
The wave period determined by the inverse of the frequency at which the wave energy spectrum reaches its maximum.

Percolation
Flow of a liquid through an unsaturated porous medium.

Perennial stream
A stream that flows from source to mouth throughout the year.

pH
A measure of acidity or alkalinity of water on a log scale from 0 (extremely acidic) through 7 (neutral) to 14 (extremely alkaline). It is the negative base-10 log of the hydrogen ion (H+) activity in moles per litre.

Photosynthesis
The process whereby pigments such as chlorophyll a in plants and algae capture sunlight and covert it to organic matter and oxygen.

Phytoplankton
Microscopically small plants that float or swim weakly in fresh or saltwater bodies.

Point Source
A source of sediment or nutrients that is restricted to one discharge location.

Point source of pollution
A single, identifiable, discrete source of air or water pollution, including stationary sources, such as sewage treatment plants, power plants and other industrial establishments, and pipes, ditches, ships, ore pits and smokestacks.

Policy
Any form of intervention or societal response. This includes not only statements of intent, such as a water policy or forest policy, but also other forms of intervention, such as the use of economic instruments, market creation, subsidies, institutional reform, legal reform, decentralization and institutional development. Policy can be seen as a tool for the exercise of governance. When such an intervention is enforced by the state, it is called public policy.

Pollutant
Any substance that causes harm to the environment when it mixes with soil, water or air.

Pollution
The presence of minerals, chemicals or physical properties at levels that exceed the values deemed to define a boundary between 'good or acceptable' and 'poor or unacceptable' quality, which is a function of the specific pollutant.

Port
A place where vessels may discharge or receive cargo.

Poverty
The pronounced deprivation of well-being.

Precautionary approach
The management concept stating that in cases where there are threats of serious or irreversible damage, lack of full scientific certainly shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Precipitation
A chemical reaction in which a previously dissolved substance forms an insoluble solid substance which drops out of solution (i.e. precipitates).

Prediction
The act of attempting to produce a description of the expected future, or the description itself.

Preparedness
Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations.

Pressures
The driving forces behind changes often result from human activities and uses, although natural climate change and natural disasters can also constitute causal pressures or ecosystem forcing functions.

Primary pollutant
Air pollutant emitted directly from a source.

Pristine area
An area in its virginal or original state, untouched by human society,

Probability
The likelihood of a defined hazard event impacting a coastal area.

Projection
The act of attempting to produce a description of the future subject to assumptions about certain preconditions, or the description itself.

Protected area
A geographically defined area that is designed and managed to achieve specified environmental objectives.

Provisioning services
The products obtained from ecosystems, including, for example, genetic resources, food and fibre, and freshwater.

R

Rangeland
An area where the main land use is related to the support of grazing or browsing mammals, such as cattle, sheep, goats.

Rapid-onset hazard
A hazard that impacts over a short time-scale (minutes-hours), sometimes catastrophically.

Relative sea level
Sea level measured by a tide gauge with respect to the land upon which it is situated. Mean sea level is normally defined as the average relative sea level over a period, such as a month or a year, long enough to average out transients such as waves and tides.

Rare Species
Small populations of species that are not currently endangered or vulnerable, but are at risk. These species are usually localized within restricted geographical area or habitats or are thinly scattered over a more extensive range. Rarity can be defined locally, regionally, provincially/ territorially, nationally or globally.

Reach
(1) An arm of the ocean extending into the land. (2) a straight section of restricted waterway of considerable extent; may be similar to a narrows, except much longer in extent.

Recession
(1) A continuing landward movement of the shoreline. (2) a net landward movement of the shoreline over a specified time.

Reforestation
Planting of forests on lands that have previously contained forest, but have since been converted to some other use.

Refraction
The process by which the direction of a wave moving in shallow water at an angle to the bottom contours is changed. The part of the wave moving shoreward in shallower water travels more slowly than that portion in deeper water, causing the wave to turn or bend to become parallel to the contours.

Regional sea
An ocean space within which the ecosystem merits protection, and also within which the development of coastal and island states would benefit from the international co-operation

Rehabilitation
The return of a species, population, habitat or ecosystem to a healthy, functioning state.

Renewable energy source
An energy source that does not rely on finite stocks of fuels. The most widely known renewable source is hydropower; other renewable sources are biomass, solar, tidal, wave and wind energy.

Report cards
Report cards rate the overall condition of marine and estuarine areas (or other), as well as aspects of habitat extent and quality. They generally represent the culmination of twelve months of scientific monitoring at sites within a specified jurisdiction.

Resilience
The capacity of a system, community or society potentially exposed to hazards to adapt by resisting or changing in order to reach and maintain an acceptable level of functioning and structure.

Resistance
The capacity of a system to withstand the impacts of drivers without displacement from its present state.

Resources harvesting
The harvesting of biological resources for the purpose of subsistence or economic gain. Includes both aquatic and terrestrial resources.

Restoration
The return of a species, population or ecosystem to its state prior to disturbance.

Resuspension
The process by which currents and turbulence dislodge settled particles and mix them back into the water column. Fine sediments in the bed tend to stick together due to electrostatic forces.

This cohesiveness is a property of the sediment mineralogy and also whether the sediment surface is covered by biogenic films or not. Such cohesive sediments may not resuspend until a critical flow speed is exceeded, which may be much higher than for coarser particles.

Return period
Average period of time between occurrences of a defined event.

Revetment
(1) A facing of stone, concrete, etc., to protect a scarp, embankment, or shore structure, against erosion by wave action or currents. (2) a retaining wall.

Rip Current
A surface current that is often of short duration and that flows seaward from the shore.

Rip Channel
A rip channel is a channel which is formed by the seaward flow of a rip current. They are usually found to cross longshore bars.

Riparian
Related to, living or located on the bank of a natural watercourse, usually a river, but sometimes a lake, tidewater or enclosed sea.

Riparian Zone
The riparian zone is the vegetated corridor along streams and rivers. It serves a number of important functions that bear consideration in terms of farm management. The riparian zone: acts as a trap for sediments and nutrients heading from hill-slopes to streams, improving stream water quality; shades streams, lowering water temperature and altering food sources by preventing the growth of algae.

Risk management
A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend.

Rocky reefs
Rocky reefs feature a hard substrate that may occur at supra-tidal to sub-tidal elevations. Surfaces are generally non-depositional and sometimes erosional, and are usually dominated by epifaunal and algal communities.

Run-off
A portion of rainfall, melted snow or irrigation water that flows across the ground's surface and is eventually returned to streams. Run-off can pick up pollutants from air or land and carry them to receiving waters.

Run-up
The rush of water up a structure or beach on the breaking of a wave. The amount of run-up is the vertical height above still-water level that the rush of water reaches.

S

Saffir-Simpson Hurricane Scale
A scale that rates a hurricane's present intensity from 1-5 based on wind. This scale is used to provide an estimate of the potential flooding and property damage that may be expected from a

cyclone. Wind speeds in these categories refer to sustained winds. Gusting wind speeds can be much higher.

Saline intrusion
Saline intrusion is the influx of sea water into an area that is not normally exposed to high salinity levels.

Salinity
Salinity is the mass fraction of salts in water.

Salinization
The buildup of salts in soils.

Saltflats
Saltflats, or saline supratidal mudflats occur in dry evaporative environments (often in the tropics) that undergo infrequent tidal inundation.

Saltmarsh
A coastal saltmarsh is a community of plants and animals that grow along the upper-intertidal zone of coastal waterways.

Salt-wedge
An intrusion of sea water into a coastal waterway in the form of a wedge along the seabed. The lighter fresh water from riverine sources overrides the denser salt water

Sand
An unconsolidated (geologically) mixture of inorganic soil (that may include disintegrated shells and coral) consisting of small but easily distinguishable grains ranging in size from about .062 mm to 2.0 mm.

Scale
The spatial, temporal (quantitative or analytical) dimension used to measure and study any phenomena. Specific points on a scale can thus be considered levels (such as local, regional, national and international).

Scenario
A plausible and often simplified description of how the future might develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often based on additional information from other sources, sometimes combined with a narrative storyline.

Scour protection
Protection against erosion of the seabed in front of the toe.

Seagrass
Marine flowering plants which generally attach to the substrate with roots.

Seagrass bed
Benthic community, usually on shallow, sandy or muddy bottoms of sea dominated by grass-like marine plants.

Sea defences
Works to prevent or alleviate flooding by the sea.

Seawall
(1) A structure built along a portion of a coast primarily to prevent erosion and other damage by wave action. It retains earth against its shoreward face. (2) a structure separating land and water areas primarily to prevent erosion and other damage by wave action. Generally more massive and capable of resisting greater wave forces than a bulkhead.

Seawater intrusion
The influx of sea water into an area that is not normally exposed to high salinity levels.

Security
Relates to personal and environmental security. It includes access to natural and other resources, and freedom from violence, crime and war, as well as security from natural and human-caused disasters.

Sediment
Solid material that originates mostly from disintegrated rocks and is transported by, suspended in or deposited from water.

Sediment cell
In the context of a strategic approach to coastal management, a length of coastline in which interruptions to the movement of sand or shingle along the beaches or nearshore seabed do not significantly affect beaches in the adjacent lengths of coastline.

Sediment load
The amount of non-dissolved matter that passes through a given river cross section per unit time.

Sedimentation
Strictly, the act or process of depositing sediment from suspension in water. Broadly, all the processes whereby particles of rock material are accumulated to form sedimentary deposits. Sedimentation, as commonly used, involves not only aqueous but also glacial, aeolian and organic agents.

Sediment transport
The main agencies by which sedimentary materials are moved are: gravity (gravity transport); running water (rivers and streams); ice (glaciers); wind; the sea (currents and longshore drift). Running water and wind are the most widespread transporting agents. In both cases, three mechanisms operate, although the particle size of the transported material involved is very different, owing to the differences in density and viscosity of air and water. The three processes are: rolling or traction, in which the particle moves along the bed but is too heavy to be lifted from it; saltation; and suspension, in which particles remain permanently above the bed, sustained there by the turbulent flow of the air or water.

Semi-enclosed sea
A sea in which 50% of the periphery is occupied by land.

Sensitivity
The degree of susceptibility to impacts.

Setback
A required open space, specified in shoreline master programs, measured horizontally upland from a perpendicular to the ordinary high water mark.

Shallow water
Water of such depth that surface waves are noticeably affected by bottom topography. Typically this implies a water depth equivalent to less than half the wave length.

Shared waters
Water resources shared by two or more governmental jurisdictions.

Sheet runoff (or Surface Runoff)
The flow across the land surface of water that accumulates on the surface when the rainfall rate exceeds the infiltration capacity of the soil.

Shoal
(1) A detached area of any material except rock or coral. The depths over it are a danger to surface navigation. Similar continental or insular shelf features of greater depths are usually termed banks.

Shore
That strip of ground bordering any body of water which is alternately exposed, or covered by tides and/or waves. A shore of unconsolidated material is usually called a beach. The zone between low tide and the highest point reached by waves or tides.

Shoreline
The intersection of a specified body of water with the shore.

Significant wave height
Average height of the highest one-third of the waves for a stated interval of time.

Significant wave period
Average period of the highest one-third of the waves for a stated interval of time.

Siltation
The deposition of finely divided soil and rock particles on the bottom of stream and riverbeds and reservoirs.

Smog
Classically a combination of smoke and fog in which products of combustion, such as hydrocarbons, particulate matter and oxides of sulphur and nitrogen, occur in concentrations that are harmful to human beings and other organisms. More commonly, it occurs as photochemical smog, produced when sunlight acts on nitrogen oxides and hydrocarbons to produce tropospheric ozone.

Soft defences
Usually refers to beaches (natural or designed) but may also relate to energy-absorbing beach control structures, including those constructed of rock, where these are used to control or redirect coastal processes rather than opposing or preventing them.

Soft law
Non-legally binding instruments, such as guidelines, standards, criteria, codes of practice, resolutions, and principles or declarations established to implement national or international laws.

Species
An interbreeding group of organisms that is reproductively isolated from all other organisms, although there are many partial exceptions to this rule in particular taxa. Operationally, the term species is a generally agreed fundamental taxonomic unit, based on morphological or genetic similarity that once described and accepted is associated with a unique scientific name.

Species diversity
Biodiversity at the species level, often combining aspects of species richness, their relative abundance and their dissimilarity.

Species richness/abundance
The number of species within a given sample, community or area.

Spring tide
A tide that occurs at or near the time of new or full moon, and which rises highest and falls lowest from the mean sea level (MSL).

Stability
In the context of coastal landforms, stability refers to their degree of susceptibility to physical change.

Structural measures
Structural measures refer to any physical construction to reduce or avoid possible impacts of hazards, which include engineering measures and construction of hazard-resistant and protective structures and infrastructure.

Stakeholders
Individuals or groups (community groups, government organisations, investors) who have a direct or indirect interest or claim (stake) which may be affected by a particular decision or policy.

Stormwater
Stormwater runoff comprises all forms of runoff from urban areas. It is enhanced by the web of impervious surfaces, including roads, roofs, footpaths, car parks and other structures, and is conveyed to coastal waterways by natural and man-made conduits and drains.

Streambed and Streambank Erosion
The removal of river banks by flowing water.

Stillwater level (SWL)
The surface of the water if all wave and wind action were to cease. In deep water this level approximates the midpoint of the wave height. In shallow water it is nearer to the trough than the crest. Also called the undisturbed water level.

Storm surge
An abnormal rise in sea level accompanying a hurricane or other intense storm, whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the cyclone.

Stress
From an ecological perspective, a stress is a change that causes a response in a system or population of interest.

Stressors
Physical, chemical and biological components of the environment that, when changed by human or other activities, can result in degradation to natural resources.

Subsidence
The downward settling of the Earth's crust relative to its surroundings.

Substrate
The sediment and other material that comprises the seabed (or floor of coastal waterway).

Sub-tidal
Permanently below the level of low tide, an underwater environment.

Susceptibility
The predisposition to be affected by physical or socioeconomic change, including damage or loss. Often taken to be broadly synonymous vulnerability.

Surface water
All water naturally open to the atmosphere, including rivers, lakes, reservoirs, streams, impoundments, seas and estuaries. The term also covers springs, wells or other collectors of water that are directly influenced by surface waters.

Surf zone
The near-shore part of a beach where waves become breakers. This typically occurs at water depths between 5 m and 10 m.

Surge
Wave motion with a period intermediate between that of an ordinary wind wave and that of the tide. Changes in water level as a result of meteorological forcing (wind, high or low barometric pressure) causing a difference between the recorded water level and that predicted using harmonic analysis, may be positive or negative.

Suspended Sediment
Sedimentary material subject to transport by flowing water (e.g. currents) that is carried in suspension. Typically comprises relatively fine particles that settle at a lower rate than the upward velocity of water eddies.

Sustainability
A characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs.

Sustainable
A description of a process or state that can be maintained indefinitely.

Sustainable development
Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

Sustainable harvest rate
The rate of harvest that is within an ecosystem's natural ability to recover and regenerate.

Sustainable use
The use of components of biodiversity in a way and at a rate that does not lead to their long-term decline thereby maintaining the potential for future generations to meet their needs and aspirations. sustainable use in this strategy refers to consumptive uses of biological resources.

Swash zone
The zone of wave action on the beach, which moves as water levels vary, extending from the limit of run-down to the limit of run-up.

Swell
Waves that have travelled a long distance from their generating area and have been sorted out by travel into long waves of the same approximate period.

T

Tailings
Residue of raw materials or waste separated out during the processing of crops, mineral ores or oil sands.

Technology transfer
A broad set of processes covering the flows of know-how, experience and equipment among different stakeholders.

Thermal expansion
In connection with sea level, this refers to the increase in volume (and decrease in density) which results from warming water. A warming of the ocean leads to an expansion of the ocean volume and hence an increase in sea level.

Threat
A source of impending danger or harm to the condition of natural resource assets or the services they provide. Can include both pressures and stressors

Threatened Species
Species that are likely to become endangered if the natural or human pressures causing them to be vulnerable are not reversed.

Tidal Current
An alternating, horizontal movement of water associated with the rise and fall of the tide, these movements being caused by gravitational forces due to the relative motions of moon, sun and Earth.

Tidal Prism
Volume of water moving into and out of an estuary or coastal waterway during the tidal cycle.

Tidal sand banks
Tidal sand banks are sedimentary features commonly found within tide-dominated estuaries, deltas and tidal creeks. Tidal sand banks are typically subtidal to intertidal in elevation, and consist of elongate linear to sinuous sand bars comprised of moderate- to well-sorted fine muds to sands.

Tide gauge
A device at a coastal location (and some deep-sea locations) that continuously measures the level of the sea with respect to the adjacent land. Time averaging of the sea level so recorded gives the observed secular changes of the relative sea level.

Tide(s)
The alternating rise and fall of the surface of the ocean and connected waters, such as estuaries and gulfs, that results from the gravitational forces of the Moon and Sun; also called astronomical tides (see tides, astronomical).

Tipping point
The tipping point is the critical point in an evolving situation that leads to a new and irreversible development.

Traditional or local ecological knowledge
A cumulative body of knowledge, know-how, practices or representations maintained or developed by peoples with extended histories of interaction with the natural environment.

Trophic level
Successive stages of nourishment as represented by the links of the food chain. According to a grossly simplified scheme the primary producers (phytoplankton) constitute the first trophic level, herbivorous zooplankton the second trophic level and carnivorous organisms the third trophic level.

Toe
(1) Lowest part of sea- and portside breakwater slope, generally forming the transition to the seabed. (2) the point of break in slope between a dune and a beach face.

Topographic map
A map on which elevations are shown by means of contour lines.

Turbidity
A measure of water clarity or murkiness. It is an optical property that expresses the degree to which light is scattered and absorbed by molecules and particles. Turbidity results from soluble coloured organic compounds and suspended particulate matter in the water column.

U

Updrift
The direction to which the predominant longshore movement of beach material approaches.

Upwelling
The slow upward transport of cold, nutrient-rich water masses to the surface from depth. Coastal upwelling is usually induced by surface winds.

Urban sprawl
The decentralization of the urban core through the unlimited outward extension of dispersed development beyond the urban fringe, where low density residential and commercial development exacerbates fragmentation of powers over land use.

Urban systems
Built environments with a high human population density. Operationally defined as human settlements with a minimum population density commonly in the range of 400–1 000 persons per square kilometre, minimum size of typically between
1 000 and 5 000 people, and maximum (non-)agricultural employment usually in the range of 50–75 per cent.

Urbanization
An increase in the proportion of the population living in urban areas.

V

Vector organisms
Organisms that transmit certain diseases.

Voluntary agreement
An agreement between government and business, or a unilateral private sector commitment that is acknowledged by the government, aimed at achieving environmental objectives or improving environmental performance.

Vulnerable Species
Species that are risk because they exist in low numbers or in restricted ranges due to over-exploitation, extensive habitat destruction or other factors.

W

Wastewater
There are two main types of wastewater: domestic wastewater (i.e. waterborne wastes from households (e.g. faecal matter, urine, and waste from bathroom basins)); and industrial wastewater (i.e. waterborne waste that is generated in industrial processes (including sewage treatment plants).

Wastewater treatment
Any of the mechanical, biological or chemical processes used to modify the quality of wastewater in order to reduce pollution levels.

Water quality
The chemical, physical and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Waterscapes
Complexes of aquatic ecosystems in geographically defined areas.

Water table
The top of the water surface in the saturated part of an aquifer.

Wave
A periodic and repeating disturbance that travels through water (or other medium) from one location to another location.

Wave crest
(1) The highest part of the wave. (2) that part of the wave above still water level.

Wave direction
The direction from which the waves are coming.

Wave height
The vertical distance between the crest (the high point of a wave) and the trough (the low point).

Wave hindcast
The calculation from historic synoptic weather charts of the wave characteristics that probably occurred at some past time.

Wave length
The distance, in metres, between equivalent points (crests or troughs) on waves.

Wave period:
(1) The time required for two successive wave crests to pass a fixed point. (2) the time, in seconds, required for a wave crest to traverse a distance equal to one wave length.

Wave rose
Diagram showing the long-term distribution of wave height and direction.

Wave set-up
Elevation of the still-water level due to breaking waves.

Wave steepness
The ratio of wave height to its length. Not the same thing as the slope between a wave crest and its adjacent trough.

Wave train
A series of waves from the same direction.

Wave trough
The lowest part of the wave form between crests. Also that part of a wave below still water level.

Wave variability
(1) The variation of heights and periods between individual waves within a wave train. Wave trains are not composed of waves of equal heights and periods, but rather of heights and periods which vary in a statistical manner. (2) the variability in direction of wave travel when leaving the generating area. (3) the variation in height along the crest.

Wetlands
Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres and may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands.

Wild flora and fauna and other wild organisms
Includes mammals, birds, reptiles, amphibians, fishes, invertebrates, plants, protists, viruses, fungi, algae and bacteria.

Wind rose
Diagram showing the long-term distribution of wind speed and direction.

Wind setup
(1) The vertical rise in the stillwater level on the leeward side of a body of water caused by wind stresses on the surface of the water. (2) the difference in stillwater levels on the windward and the leeward sides of a body of water caused by wind stresses on the surface of the water. (3) synonymous with wind tide and storm surge. Storm surge is usually reserved for use on the ocean and large bodies of water. Wind setup is usually reserved for use on reservoirs and smaller bodies of water.

Wind waves
(1) Waves formed and growing in height under the influence of wind. (2) loosely, any wave generated by wind.

Woodland
Wooded land, which is not classified as forest, spanning more than 0.5 hectares, with trees higher than 5 metres and a canopy cover of 5-10 per cent, or trees able to reach these thresholds *in situ*, or with a combined cover of shrubs, bushes and trees above 10 per cent. It does not include areas used predominantly for agricultural or urban purposes.

World Geodetic System, 1984 (revised 2004)
An earth fixed global reference frame used for defining coordinates when surveying and by GPS systems.

Z

Zooplankton
Non-photosynthetic, heterotrophic planktonic organisms, including protists, small animals, and larvae, which exist within the water column.

Appendix B: List of Acronyms

BAMS ....Beach Analysis and Management System
CARIBE-EWS Tsunami and Other Coastal Hazards Warning System for the Caribbean and Adjacent Regions
CARICOM ....Caribbean Community Secretariat
CCL ....Coastal Construction Line
CEP ....Caribbean Environment Program
CSA ....Canadian Standards Association
CUBiC ....Caribbean Uniform Building Code
DFL ....Designated Flood Level
EAM ....Ecosystems Approaches to Management
EPA ....Environmental Protection Agency
EU ....European Union
FEMA ....Federal Emergency Management Agency
GEF ....Global Environment Facility
GHG ....Greenhouse Gases
GIS ....Geographical Information System
GLOSS ....Global Sea Level Observing System
GPS ....Global Positioning System
FAO ....Food and Agriculture Organization of the United Nations
FCRP ....Flood Construction Reference Plane
HAT ....Highest Astronomical tide
HFCs ....Hydrofluorocarbons
HHWLT ....Higher High Water, Large Tide
HRM ....Halifax Regional Municipality
HWM ....High Water Mark
ICAM ....Integrated Coastal Area Management
ICM ....Integrated Coastal Management
ICZM ....Integrated Coastal Zone Management
IDB ....Inter-American Development Bank
IOC ....Intergovernmental Oceanographic Commission
IPCC ....Intergovernmental Panel on Climate Change
IPM ....Integrated Pest Management
ISDR ....United Nations International Strategy for Disaster Relief
IWRM ....Integrated Water Resources Management
LAC ....Latin American and Caribbean Region
LIDAR ....Light Detection and Ranging ground/seabed survey technique
LLWLT ....Lower Low Water, large Tide
MEQ ....Marine Environmental Quality
MHW ....Mean High Water
MHWS ....Mean High Water Springs
MPA ....Marine Protected Area
MSL ....Mean Sea Level
NGO ....Non-Governmental Organisation
NOAA ....National Oceanic and Atmospheric Administration

OECS ....Organization of Eastern Caribbean States
PFCs ....Perfluorocarbons
RMA ....Resource Management Act
SBEACH ....Storm-induced Beach Change Model
SME ....Small and medium-sized enterprises
SWL ....Stillwater Level
UNEP ....United Nations Environment Program
UNESCO ....United Nations Educational, Scientific and Cultural Organisation
UNFCCC ....United Nations Framework Convention on Climate Change
UN/ISDR ....see ISDR
UNU-EHS .....United Nations University, Institute for Environment and Human
WMO ....World Meteorological Organisation

Appendix C: Summary of Coastal Setbacks by Country

Country	Setback Distance	Reference Point	Link/Notes
Anguilla	50-300ft (15-91m)	Line of vegetation	http://www.gov.ai/planning/Anguilla%20Planning%20Bill%202001%20Final.htm http://www.unesco.org/csi/pub/info/info410.htm
Antigua & Barbuda	18-91m	Line of vegetation	http://ab.gov.ag/pdf/120103%20Draft%20NPDP%202011.pdf http://www.unesco.org/csi/act/cosalc/cosalc1.pdf
Argentina			
Bahamas	5-15m	Line of vegetation, ridge, or dune crest	http://www.horsleywitten.com/pubs/ICZM-Bahamas.pdf
Barbados	30m 10m cliff top	High water mark	Unique features can expand this limit, existing buildings can reduce it http://www.coastal.gov.bb/info.cfm?category=2&catinfo=9 http://faolex.fao.org/docs/pdf/bar18058.pdf
Belize	66 feet (20m)		National Lands Act, Volume IV Chapter 191 Sec. 12 (8) http://www.belizelaw.org/lawadmin/index2.html http://www.coastalzonebelize.org/wp-content/uploads/2010/04/state_ofthe_coast_report_2000.pdf
Brazil	50-200m	Tidal Line	
Chile	80m		
Colombia	50m		
Costa Rica	50m + 150m	Ordinary high tide	Law of the Maritime and Terrestrial Zone http://www.visitcostarica.com/ict/paginas/leyes/pdf/Regulation_of_the_Law_of_the_Maritime_and_Terrestrial_Zone.pdf
Cuba	40-80m	Line of vegetation, ridge, or dune crest	http://www.edf.org/sites/default/files/9621_Cuba_Decree-Law_212.pdf http://nsgl.gso.uri.edu/riu/riuc04001/riuc04001_part3.pdf Article 3
Dominican Republic	60m	High water mark	http://www.medioambiente.gov.do/cms/archivos/legislacion/ley202-04.pdf http://www.medioambiente.gov.do/cms/archivos/legislacion/ley64.pdf
Ecuador	8m + mangrove greenbelt		
El Salvador			
Grenada			None adopted beyond specific environmental assessments
Guatemala			
Guyana			
Haiti			
Honduras			Exec order 012-96
Jamaica			
Mexico	20m		
Nevis	60-500 ft (18-152m)	Line of vegetation	http://www.unesco.org/csi/act/cosalc/cosalc2a.pdf
Nicaragua	50m	High tide line	http://www.canatur-nicaragua.org/downloads/ley690-en.pdf Article 19
Panama	20m		
Peru			
St Kitts			
St. Lucia			
Suriname			

Country	Setback Distance	Reference Point	Link/Notes
Trinidad and Tobago			National Coastal Zone Management Plan under development http://www.wrmu.org.tt/Content.aspx?SectionId=35
Uruguay	250m	High water mark	http://200.40.229.134/leyes/AccesoTextoLey.asp?Ley=14859&Anchor= Article 153
Venezuela	50m		
EU - Mediterranean	100m minimum	Highest winter water mark	http://www.pap-thecoastcentre.org/razno/PROTOCOL%20ENG%20IN%20FINAL%20FORMAT.pdf http://www.pap-thecoastcentre.org/about.php?blob_id=56 http://www.iddri.org/Publications/Collections/Analyses/AN_1005_article%208-2%20ICZM%20protocol.pdf http://www.coastalguide.org/pub/instruments.pdf
Germany	100-200m		Schleswig-Holstein National Park Act, Mecklenburg-Vorpommern Nature Protection Law
Norway	100m	shoreline	national policy guideline
Poland	200m		Act on Marine Areas of the Polish Republic and Maritime Administration 1991
Turkey	50m	shore edge line	Shore Law
Spain	100m	landward limit of the shore	National Shores Act
Sweden	100m	shoreline	Environmental Code
Denmark	300m		Nature Protection Act
Australia			http://www.planning.wa.gov.au/dop_pub_pdf/SPP_2_6.pdf http://www.ashburton.wa.gov.au/building-and-town-planning/projects/onslow-townsite-planning-coastal-setbacks-and-development-levels/
New South Wales	1km	high water mark	
Victoria	200m	high water mark	
South Australia	100M	high water mark	
New Zealand	66 ft (20m)		http://www.doc.govt.nz/upload/documents/conservation/marine-and-coastal/coastal-management/nz-coastal-policy-statement-2010.pdf Prior 1994 Policy: http://www.doc.govt.nz/upload/documents/conservation/marine-and-coastal/coastal-management/nz-coastal-policy-statement-1994-superseded.pdf http://otago.ourarchive.ac.nz/bitstream/handle/10523/1677/AlexandraScouller2010MPlan.pdf?sequence=1
Canada			
New Brunswick	30m	higher high water large tide	
British Columbia	15m	flood construction level in 2100	
Halifax	2.5m elevation	high water mark	

Appendix D: Summary of Coastal Setbacks in the United States of America

State	Setback Distance (Feet)	Reference Point	Notes
Alabama	Coastal Construction Line (CCL)	Mean high tide	CCL is an arbitrary line on a map
American Samoa	200 feet	Mean high tide	
Delaware	100 feet 1,000 feet	10 foot elevation height Mean high water	Whichever is most seaward
Florida	30x erosion rate Coastal Construction Line	Seasonal high water	Whichever is most seaward. CCL is an arbitrary line on a map
Georgia	Line of vegetation	Low water mark	
Guam	35 feet 75 feet	Mean high water mark	Structures ≤20 feet high Structures > 20 feet high
Hawaii	20-40 feet 40 feet plus 70x annual coastal erosion 40-90 feet Depending on Lot Depth	Upper wash of waves at high tide	Shoreline Area Conservation Area lots with greater than 200 feet of depth Conservation Area lots with less than 100 feet of depth at 40 feet, plus 10 feet for every 20 feet of depth
Maine	25 feet 75 feet	tide mark High	General Development Districts Shore land Zone
Michigan	15 feet, plus 30x erosion rate 15 feet, plus 60x erosion rate	Erosion Hazard Line	Small Structures Larger Structures
Minnesota	40 feet 75 feet	Line of vegetation Average water level	Whichever is greater
New Hampshire	50 feet	Highest Astronomical Tide	
New Jersey	Seaward foot of dunes 25 feet landward of crest/50x erosion 30x erosion rate/ 60x erosion rate 30x erosion rate/ 60x erosion rate 30x erosion rate/ 60x erosion rate 30x erosion rate/ 60x erosion rate Inland limit of sediment transport 100 feet	Mean High Water 25 feet seaward of bluff toe/HWL Bluff crest Most seaward dune crest First vegetation line Landward beach edge/8' contour Seaward toe of dune/landward beach edge Navigable water body	Beaches Coastal Bluffs Erosion Hazard Areas – Coastal Bluffs Erosion Hazard Areas – Unvegetated Dunes Erosion Hazard Areas – Vegetated Dunes Erosion Hazard Areas – Non-dune Areas Overwash Areas In Flood Hazard Areas
New York	Seaward/lake ward toe of dune/bluff 100 feet 25 feet 25 feet 40x erosion rate	Mean low water Line of permanent vegetation Bluff's receding edge/point of inflection Landward beach boundary Landward limit of fronting natural protective feature	Beaches with bluffs or dunes Beaches without bluffs or dunes Bluffs Primary Dunes Structural Hazard Areas

State	Setback Distance (Feet)	Reference Point	Notes
North Carolina	Landward of crest of primary/frontal dune, or Ocean Hazard Setback, whichever is most landward	Line of stable natural vegetation	Ocean Hazard Setback is the greater of; 30x erosion rate/60 feet for structures <5,000 square feet 60x erosion rate/120 feet for structures 5,000 -9,999 square feet 90x erosion rate/180 feet for structures ≥ 10,000 square feet
Oregon	Line of vegetation Point of definite change in material type or landform or vegetation line	Low water line	Ocean Shores Beaches
Pennsylvania	Structure lifespan x erosion rate, minimum of 25 feet	Bluff edge or crest	Residential: 50 years Commercial: 75 years Industrial: 100 years
Puerto Rico	approximately 150 feet (50m) 2.5 x building height	High tide line	Whichever is greater
Rhode Island	30x erosion rate (Residential) 60x erosion rate (Commercial) 50 feet 25 feet from Coastal Buffer Zone	Inland boundary of most landward coastal features	Whichever is greater
South Carolina	Escarpment Line of vegetation	Ocean	Whichever is greater
Texas	Line of Vegetation Up to 1000 feet	Mean Low Tide Mean High Tide	Public Beach Critical Dune Areas
U.S. Virgin Islands	50 feet First line of vegetation Natural barrier	Line of low tide	Whichever is most seaward
Virginia	Line of woody vegetation Landward dune grade <10% 20x erosion rate	Low water line Mean high water Dune crest	Beaches Coastal Primary Sand Dunes Barrier Islands
Wisconsin	75 feet	Ordinary high water mark	

Appendix E: The Cairo Principles (as extracted from UNEP/GPA 2009)

1 (***Overarching Principle***) Reduce the vulnerability of coastal communities to natural hazards by establishing a regional early warning system; and applying construction setbacks, greenbelts and other no-build areas in each nation, founded on a *science-based* mapped reference line.

Using concepts of integrated coastal management, including public engagement in local decision-making, employ a rapid assessment zoning and planning process to:

2 Promote early resettlement with provision for safe housing; debris clearance; potable water, sanitation and drainage services; and access to sustainable livelihood options.

3 Enhance the ability of the natural system to act as a bio-shield to protect people and their livelihood by conserving, managing and restoring wetlands, mangroves, spawning areas, sea grass beds and coral reefs; and by seeking alternative sustainable sources of building materials, with the aim of keeping coastal sand, coral mangroves and rock in place.

4 Promote design that is cost-effective, appropriate and consistent with best practice and placement of infrastructure away from hazard and resource areas, favouring innovative and soft engineering solutions to coastal erosion control.

5 Respect traditional public access and uses of the shoreline, and protect religious and cultural sites.

6 Adopt ecosystem based management measures; promote sustainable fisheries management in overfished areas, and encourage low impact aquaculture.

7 Promote sustainable tourism that respects setback lines and carrying capacity, benefits local communities and applied adequate management practices.

How things are done is as important, sometimes more important, than what is done. Local knowledge and insights are critically important to successful planning and decision-making, and local citizens must be engaged in the rehabilitation and reconstruction process at every stage. It is essential that the application of the construction setback line and the boundaries of bio shields are defined in consultation with the local communities coastal reach by coastal reach.

8 Secure commitments from governments and international organizations to abide by these Principles and build on and strengthen existing institutional arrangements where possible.

9 Ensure public participation through capacity building and the effective utilization of all means of communication to achieve outcomes that meet the needs and realities of each situation.

10 Make full use of tools such as strategic environment assessment, spatial planning and environmental impact assessment, to identify trade-offs and options for a sustainable future.

11 Develop mechanisms and tools to monitor and periodically communicate the outcomes of the reconstruction through indicators that reflect socioeconomic change and ecosystem health.

12 Widely disseminate good practices and lessons learned as they emerge.

Appendix F: Sample Coastal Development Guidance

The material provided in this Appendix has been adapted from GOC/NB. 2005. A coastal areas protection policy for New Brunswick. Sustainable Planning Branch, Department of the Environment and Local Government, Government of New Brunswick Fredericton, NB. 15 pp., other documentation and procedures, and the authors combined experience.

Prohibited, Acceptable and Accommodated Activities and Works

Activities normally prohibited at the shoreline:

- groins or rigid structures built out from a shore to protect the shore from erosion, to trap sand and/or to redirect a current;
- infilling;
- dredging, excavation and associated spoil disposal activities; except as permitted by relevant authorities
- beach quarrying or sand removal; and
- causeways where a bridge is a technically and financially feasible alternative.

Activities normally acceptable in coastal setback areas

- traditional fisheries and access;
- maintenance/enhancement of coastal features (e.g. sand fencing, planting native dune grasses);
- acceptable soft armouring erosion prevention or control measures;
- development or undertakings associated with access and interpretation for recreational, educational or research purposes;
- development or undertakings that provide approved public or private access to a shoreline while protecting a coastal feature (e.g. a boardwalk);
- transportation activities and/or infrastructure deemed to be in the public interest would be considered for exemption under the policy, providing appropriate analysis had been undertaken;
- in coastal marshes that have been historically dyked for agricultural purposes:
- continuing agricultural practices;
- agricultural storage buildings for activities related to the use of that land (e.g. hay storage) where the intent is to minimize structures vulnerable to flooding during storm surges; and to reduce the investment affected when assessing the potential of marsh restoration;
- removal of control structures to allow historically dyked marshland to naturally revert to salt water marshes;
- where private residences existed prior to the designation of the coastal setback, and there is no rolling easement on the setback area, the repair of existing structures according to the following conditions:
- there is no increase in size of the building, and

- the habitable portion of the structure is reconstructed with a base floor elevation at least XX metres above the HHWLT (Higher High Water Large Tide) elevation as determined together with sea level rise projections for the site.

Planning and design, and environmental review processes:

During development processes a range of activities may or may not require review by appropriate regulatory planning and assessment processes. The following sections suggest categories under which many typical development works and activities may fall.

As these are suggestions only, and respecting that planning for each development must take into account the specific local governance and environmental conditions, caution is asked for in interpreting these lists in accordance with all applicable processes and regulatory requirements.

Permanent or semi-permanent nearshore activities and works requiring formal review

- permanent marinas, boat storage, wharves, docks, or piers, and boat launching ramps that extend below high water;
- breakwaters and jetties, seawalls, groins, coffer dams and sheet-piling;
- dredging and/or sediment disposal activities;
- roads, bridges and causeways, including repair, upgrading, opening of gates, and decommissioning;
- roads associated with coastal works that cross or impact sensitive coastal areas;
- airports;
- intake/outflow/run-off pipes and diffusers, storm water retention ponds, ditches and culverts;
- petroleum product storage and supply pipelines,
- power cables and transformer stations, communications towers and lines;
- beach nourishment, dune restoration, shoreline realignment and revegetation;
- removal, repair, rebuilding, upgrading or altering of any existing permanent works;
- beach access paths, floating and stationary boardwalks crossing dunes and tidally influenced areas;
- solid waste landfills;
- harvesting, collection, or other activities involving organic matter on coastal lands, including beach wrack or seaweed, as well as beach raking;
- opening of natural tidal barriers for water exchange purposes;
- removal of historic dykes and inundation of coastal lands;
- any coastal works not otherwise addressed.

Construction and design guidelines for works taking place in coastal areas:

- Construction materials used must not be hazardous to the coastal/ marine environment and must be clean, inorganic, non-ore-bearing, non-toxic, and obtained from a non-watercourse source;
- All necessary precautions must be taken to prevent discharge or loss of any harmful material or substance into the watercourse, including but not limited to creosote, hydrocarbons, biocides, fresh cement, lime, paint, stains, preservatives, or concrete.
- Any debris or construction material must be removed from the watercourse and coastal lands and disposed of, or placed, in a manner where it cannot be returned to the watercourse.
- Heavy machinery, equipment and pollutants are not permitted below the ordinary high water mark and must be located or stored in areas not in danger of floodwaters;
- The activity must not obstruct pedestrian access/passage in public areas;
- Construction materials are not obtained from any coastal feature;
- The proponent is, or has the consent of, the owner(s) of adjacent coastal uplands;
- There is no interference with sensitive species or their habitats (e.g. nesting turtles) or impacts to sensitive habitats (e.g. mangroves, dunes, wetlands); and

- The proponent assumes responsibility for the continued maintenance of the structure or works, as well as the clean-up of any component materials from the beach, above and below the ordinary high water mark, should the structure be damaged, destroyed, or decommissioned.

Planning and design guidelines for non-permanent or seasonal works and activities

- seasonal access works, such as floating docks and swim platforms, provided that there are no associated new permanent works or dredging activities
- boat launching ramps, provided that they do not extend seaward of the ordinary high water mark, including cases where they are part of the design of an existing seawall or bulkhead; and the coastline or bank is appropriately stabilized, if required
- boardwalks extending along, or over, dunes or coastal marshes, provided that they do not extend seaward of the ordinary high water mark; they do not require excavation or modification of the dune, marsh, or water; construction activity (e.g. disturbed area) is limited to a single corridor 1 x the width of the structure, including the cutting of vegetation and working area for motor vehicles and machinery; they are constructed on piles or poles a minimum of 1m above the dune or marsh; no fill is used; they are not associated with large-scale tourism or commercial projects which would require formal review and approval by relevant agencies; and approval has been obtained for works involving coastal marshes
- stairs or other structures used to access the beach landward of the ordinary high water mark, provided that there are no coastal marshes or dunes involved; and construction activity (e.g. disturbed area) is limited to a single corridor 1 x the width of the structure, including the cutting of vegetation and working area for motor vehicles and machinery
- erosion control works and structures, such as riprap, seawalls, and bulkheads, provided that they are located landward of the ordinary high water mark and up against the landward limit of coastal lands with no backfill required; they have a maximum height of 2 m above the elevation of the beach at the landward limit of coastal lands, or 2 m above the ordinary high water mark if no beach exists (e.g. cliff), and extend no more than 3 m seaward from the landward limit of coastal lands; they follow the contours of the landward limit of coastal lands; no construction debris or other refuse is used; sloped structures (max. 45 ° slope), which help dissipate wave energy/reflection, are used rather than vertical structures; and rock is used as construction material with nooks and crannies that help dissipate wave energy/reflection
- sand fences installed below the landward limit of coastal lands and landward of the ordinary high water mark to combat erosion, provided that they are installed and removed manually, without machinery; and construction does not interfere with the natural integrity of any dunes
- dune grass (native) planting below the landward limit of coastal lands and landward of the ordinary high water mark to combat erosion, provided that the proponent provides information indicating the location of the dune to be used as the source of the grass and its existing coverage density (%) per square metre; the dune used as the source maintains a minimum coverage density of 75% per square metre after the grass is removed; and planting and maintenance are done manually
- coastal lands clean-up activities involving the removal of human waste, debris or garbage
- any activities involving the rebuilding, replacement, alteration, repair, maintenance or modification of existing permanent structures or works that are permitted landward of the ordinary high water mark provided that they comply with the new proposed standards, as outlined in these recommendations. Also, maintenance and repair activities, which do not comply with the

new proposed standards, provided that less than 50% of the structure or works are affected; and the original construction material(s) are used to repair

Appendix G: Further Information on Setbacks

Caribbean Community Climate Change Centre: http://www.caribbeanclimate.bz/

Climate Institute of Barbados: http://www.climate.org/climatelab/Barbados

Government of the Western Cape Province: South Africa:
http://www.westerncape.gov.za/Text/2010/8/setback_line_methodology_report.pdf
http://www.bettysbay.info/index.php?option=com_content&view=article&id=140&Itemid=48

Government of South Africa Nelson Mandela Bay Municipality:
http://www.nelsonmandelabay.gov.za/Content.aspx?objID=521

Government of Western Australia Shire of Ashburton:
http://www.ashburton.wa.gov.au/building-and-town-planning/projects/onslow-townsite-planning-coastal-setbacks-and-development-levels/

Government of Western Australia Climate Change Management Toolkit:
http://www.walgaclimatechange.com.au/planning.htm

Mediterranean Coastal Alert: http://www.pap-thecoastcentre.org/newsletter/en/arhive/show/2011-07-02

Natural Resources Canada; Climate Change Impacts and Adaptation:
http://www.nrcan.gc.ca/earth-sciences/climate-change/community-adaptation/54

PRECIS Caribe: http://precis.insmet.cu/eng/Precis-Caribe.htm

UNESCO Environment and development in coastal regions and in small islands:
http://www.unesco.org/csi/pub/info/info49.htm

UNESCO Wise practices for coping with beach erosion in the Caribbean:
http://www.unesco.org/csi/wise2b.htm

USA EPA Climate Ready Estuaries: file:///C:/Users/Colleen/Documents/2%20C-CHANGE%20PDFs/Climate%20Ready%20Estuaries%20_%20U.S.%20EPA.htm

USA EPA Model Ordinances to Protect Local Resources:
http://www.epa.gov/owow/NPS/ordinance/

USA Sea Grant Institute, University of Wisconsin:
http://seagrant.wisc.edu/Home/Topics/CoastalEngineering/Details.aspx?PostID=703

USA National Sea Grant Library: http://nsgl.gso.uri.edu/libraries/hazard_erosion.html

USA NOAA Coastal and Waterfront Smartgrowth:
http://coastalsmartgrowth.noaa.gov/gettingstarted/waterfront_setbacks.html

USA NOAA Coastal Setbacks Case Studies (Kauai and North Carolina (2009)):
http://coastalmanagement.noaa.gov/initiatives/shoreline_ppr_setbacks.html#maui

WideCast Wider Caribbean Sea Turtle Conservation Network:
http://www.widecast.org/Conservation/Threats/Climate.html

World Wildlife Fund" Adaptation to Climate Change Toolkit: Coasts
http://wwf.panda.org/what_we_do/endangered_species/marine_turtles/lac_marine_turtle_programme/projects/climate_turtles/act_toolkit/

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