NATURE-BASED SOLUTIONS TO ENHANCE COASTAL RESILIENCE

By Kelsey Schueler

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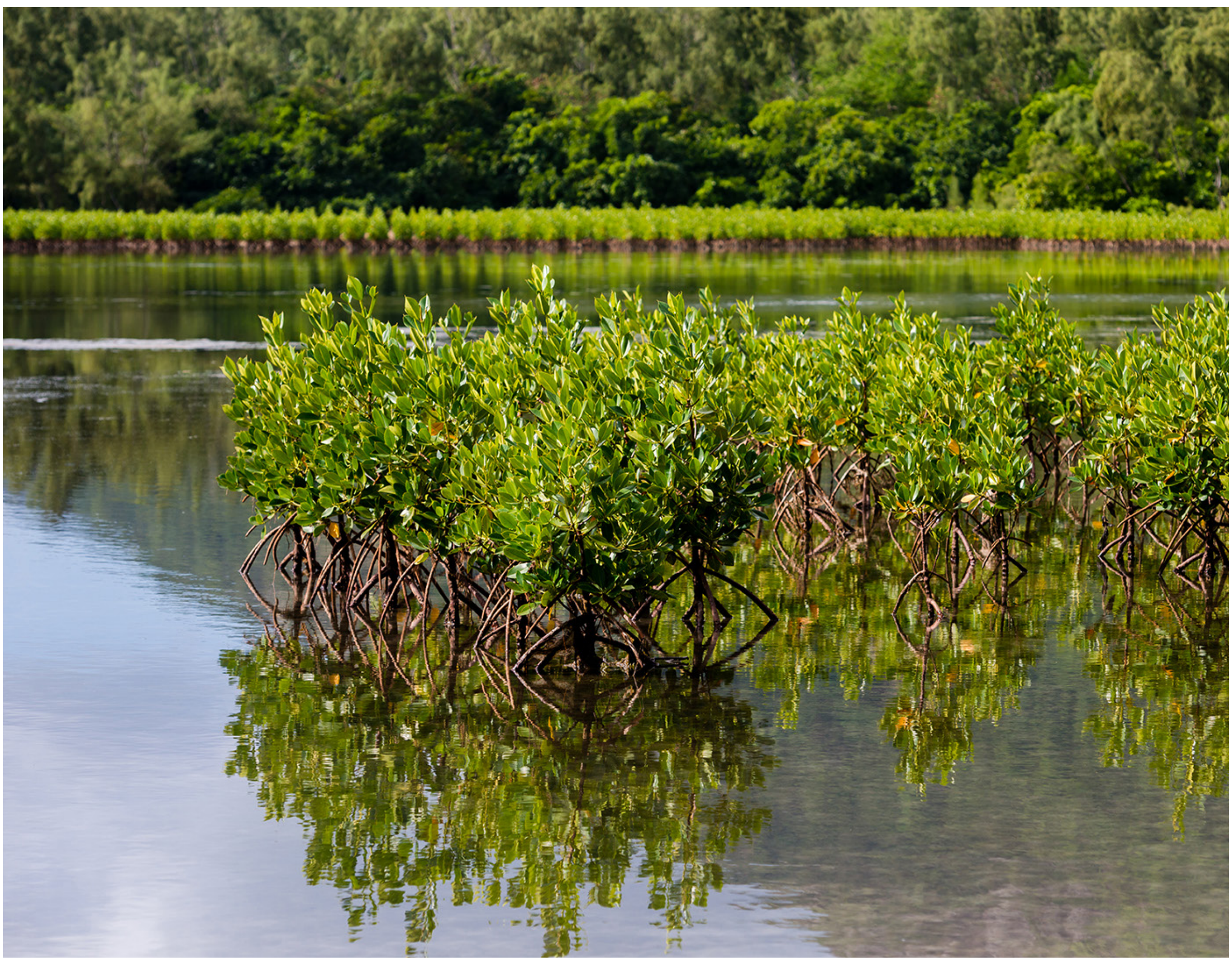
The purpose of this policy brief is to provide the Inter-American Development Bank (IDB) and its audiences with a broad overview of the importance of coastal natural capital for sustainable development. The brief highlights the role of nature-based infrastructure and integrated solutions for building coastal resilience and proposes critical areas of work to effectively address development challenges in Latin America and the Caribbean.



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Coastal Natural Capital

Latin America and the Caribbean has a wealth of coastal natural capital, including over 64,000 km of coastline[1] and one fourth of the world's mangroves[2]. Coastal areas, the interface or transition area between land and sea, are also home to approximately half of the Region's population[3], a high concentration of urban areas[4], hotspots of economic activity, centers of infrastructure, and have important cultural and social significance. It is estimated that over 23 million people in the Caribbean and Americas live both within 10 meters of sea level and within 50 meters of coral reefs or mangroves[5].

Coastal areas are inextricably linked to the Region's recent growth in both GDP and population[6]. Healthy coastal ecosystems support economies and communities with important goods and services (ecosystem services) such as fisheries, tourism, raw materials, and protection from storms and erosion. As the Region continues to grow, and more people move out of poverty, so too will the demand for infrastructure, energy, water, food, and other resources[7]. However, growth also puts the squeeze on coastal ecosystems, which already face a variety of pressures, including the impacts of climate change. Thus, international goals to reduce poverty and halt environmental degradation are interlinked and should be addressed simultaneously[8]. This is reflected in Sustainable Development Goals 13 and 14 (climate action and life below water) and the Aichi Target to conserve 10% of marine and coastal areas. In addition, many Nationally Determined Contributions submitted under the Paris Agreements include specific mitigation and adaptation actions related to coastal and marine resources. Within the Wider Caribbean Region, a specific framework established under the Cartagena Convention provides a comprehensive, umbrella agreement for the protection and development of the marine environment. While Small Island Developing States have reflected this reality in the SAMOA Pathway.

Coasts are especially important for tourism and recreation, particularly where natural resource endowments for agriculture and industry are limited, such as on islands[9]. The total contribution to GDP, including indirect and induced effects, was 9% in Latin America and 14.8% in the Caribbean[10]. The viability of tourism activity depends heavily on quality of ecosystems and biodiversity and adaptation to climate change. There is evidence that development of natural assets, protection of biodiversity and managing hazards can improve the competitiveness of tourist destinations, which contributes to the positive relationship between tourism growth and economic expansion[11]. Local recreation in coastal areas is also an important economic activity, with additional cultural and social value.

Coastal ecosystems also protect people, infrastructure, and economic activities from flooding, erosion, and sea-level rise. Increasingly, people are looking to prioritizing nature as the first line of defense for coastal protection, as well as an engine of economic growth. Compared to hard infrastructure, which is often designed for a single purpose, natural systems can provide a variety of benefits and livelihood opportunities. Coastal habitats are breeding, nursery, and feeding grounds for commercially important fish and other species; remove CO2 from the atmosphere; provide opportunities for recreation and tourism; and capture and filter pollutants to keep water clean. Thus, projects and policies designed to use coastal ecosystems to reduce vulnerability can also serve the purpose of achieving other societal, environmental, and economic goals[12].

Latin American and The Caribbean's Coasts: Vulnerable Communities and Threatened Ecosystems

These coastal areas, critical for socioeconomic well-being, are under increasing threat. Urban growth, tourism development, overfishing, and other stressors can degrade the health of coastal ecosystems, reducing ecosystem capacity and the supply of ecosystem services. The resources located where land and sea meet are often open access and therefore subject to overuse and encroachment. In addition, the value of some ecosystem services is not accounted for in decision making. For example, regulating and provisioning services often do not have market prices and a value of zero is used by default[13]. This contributes to the well-documented decline of coastal ecosystems across the region. It also highlights the importance of platforms such as Integrated Economic-Environmental Modeling[14], which enable policy makers to understand the full range of economic and environmental implications of public policy and investment alternatives.

For example, in addition to the value of reef-related tourism and fisheries, the estimated value of coastal protection provided by Caribbean coral reefs is US$0.7-2.2 billion annually[15]. However, this value is often not internalized in decision-making, resulting in degradation of coastal ecosystems. As a result, in the Caribbean, some ecologists describe a large-scale shift from coral dominated systems to algae dominated, with levels of decline in total coral cover that are unprecedented in recent history[16]. Mangroves also provide several key ecosystem services, namely coastal protection and fisheries production. Yet, reductions in mangrove cover are observed globally, with evidence of severe trends in some countries of the region. For example, mangrove loss in Barbados has been drastic, including local extinction of two species[17]. In Belize, the annual value of shoreline protection services provided by mangroves has been estimated at US$111-167 million[18].

Coastal communities, economic activity, and infrastructure are exposed to several hazards, such as coastal flooding and hurricanes. The concentration of people, including the poor, and economic activity increases the vulnerability of coastal areas. Between 1980 and 2015, Latin America and the Caribbean experienced 15 major coastal floods, with over 1,000 people killed, 1.2 million people affected and total damage of US$1.15 billion[19]. In addition to these major coastal floods, the region experiences small-scale but high frequency coastal disaster events. For example, Barbados and Jamaica reported 70 and 44 storms/storm surges between 1980 and 2013[20]. The number of coastal disaster events seems to be increasing. Of these 113 events, 56% (or 64 events) have occurred just within the last 10 years. While the impacts of climate change will differ from location to location, increases in sea level and intensity and frequency of storms are likely and already observed in certain places. These factors underscore the importance of building resilience[21] in coastal social-ecological systems.

Traditionally, the strategy to address coastal risk has been the use of hard coastal protection structures, often based on historical damages from erosion, or in response to a specific disaster event[22]. However, considering the projected impacts of climate change, addressing this uncertainty requires that decisions should not assume that future conditions will resemble current or past conditions[23]. Further, the cost of armoring all vulnerable coasts in the context of climate change, particularly in small-island developing states, is likely both economically unviable and unsustainable. Hard infrastructure may be the most feasible or cost-effective approach in some contexts, such as urban centers, ports, and areas where coastal habitats such as mangroves and coral were not historically present. However, hard infrastructure can be costly to build and maintain[24], have negative impacts on coastal habitats and biodiversity[25], reduce fishery production[26], and have unintended consequences that worsen or create new erosion issues[27]. These negative impacts can be exacerbated when structures are designed or development takes place without a strong understanding of coastal dynamics, particularly the down-stream and cumulative impacts of structures being deployed by different actors (or other non-armoring activities that influence coastal systems).

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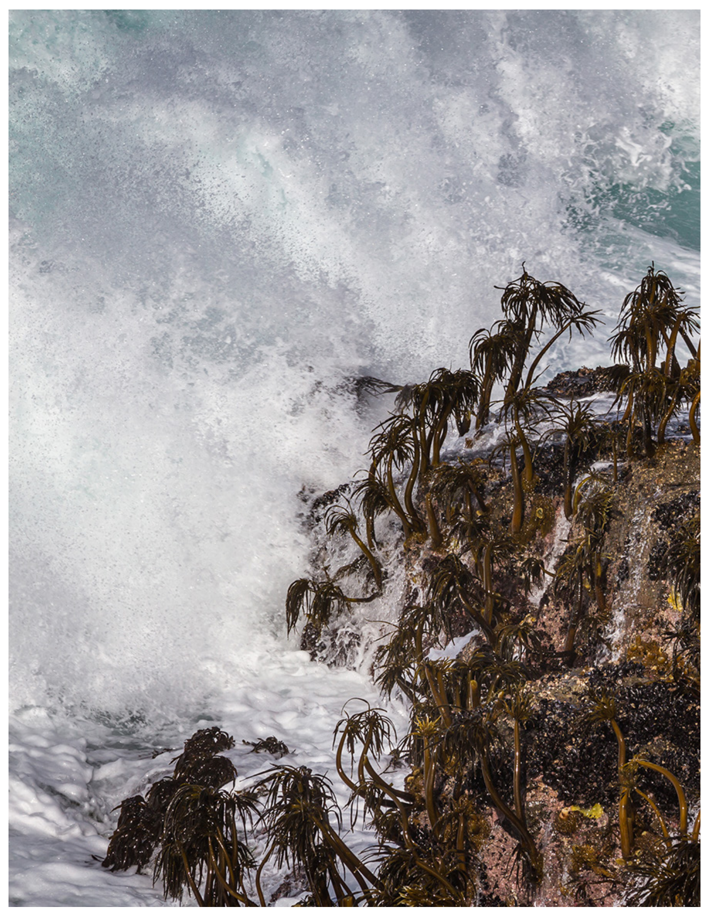
Looking to Nature

Ecosystem-based disaster risk management and climate adaptation is emerging as an innovative, economically-sound and effective approach for coastal management under certain socioeconomic and biophysical conditions. Evidence shows that the number of people, poor families, elderly, and residential property value that are most exposed to hazards may be reduced significantly (by half in some cases) if existing coastal habitats remain fully intact[28]. The services provided by coastal ecosystems are also fundamental to many livelihoods and sustenance activities (e.g. fisheries). However, the current trends of degradation and coastal resource use contribute to increasing the vulnerability of the poor[29]. Ecosystem-based approaches can address hazards, reduce vulnerability, and increase resilience.

Coastal ecosystems play a critical role in protecting and maintaining coastlines. Generally speaking, coastal ecosystems can dampen waves, attenuate water flow and flooding, reduce stormwater runoff, and build up coasts by contributing to the processes that generate, trap, and distribute sediment across shorelines. Mangroves dampen waves and reduce storm surge and flood depth[30]. Seagrasses can attenuate waves and stabilize sediments[31]. Coral reefs dampen waves and supply and trap sediment[32]. In a similar manner, oyster reefs can also reduce shoreline erosion[33]. Although highly dynamic and complex, beaches, sand banks, and dunes provide protection from storm surge and waves[34]. Also, coastal species, such as parrot fish, contribute to generation of sediment by secreting sand[35]. Actions to reduce pressure on these habitats and species (i.e., fisheries management, pollution control) can increase the health and resilience of these ecosystems, while a variety of restoration techniques exist for areas that have been lost.

Increasingly, engineers are collaborating with ecologists to expand the menu of coastal protection solutions to risks by incorporating the buffering effect of coastal ecosystems. These nature-based solutions can offer sustainable, long-term protection via their impact on sedimentation, flooding, erosion, and maintenance of tidal creeks and channels. Nature can be more resilient and adaptable than hard infrastructure and, in some cases, perform better than hard infrastructure especially for areas exposed to high-frequency, low-intensity hazards[36]. For example, mangrove root systems build up the coast, which may, under certain conditions, be able to keep pace with sea level rise[37]. Because natural systems are comprised of living organisms, they can repair and regenerate after damage, as well as move, migrate, and retreat to adapt to changing conditions. Finally, compared with hard infrastructure, which deteriorates over a finite lifespan, natural ecosystems can grow stronger over time, potentially providing more robust coastal protection as they mature[38].

Where local conditions are not suited to natural infrastructure such as in highly urbanized areas or high wave energy areas, hard infrastructure or large-scale changes to the coast can be significantly improved and more sustainable when an understanding of the coastal processes and ecosystems is incorporated in the early stages of coastal planning and development. In addition, coastal ecosystems can be combined with hard infrastructure to develop hybrid infrastructure that harnesses the strengths of each approach to improve performance of coastal protection interventions, while delivering additional benefits and enhancing livelihoods. Examples include placing vegetation in front of dikes or habitat-promoting surfaces on seawalls.



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Integrated Solutions: Policy, Science, and Capacity are Essential

In addition to nature-based protection, building coastal resilience requires complimentary investments in policy, science, and governance[39]. Integrated coastal zone management, the coordinated application of policies to balance the full range of coastal and marine activities in a manner that is resilient to climate change and compatible with sustainable development, is an important component of coastal resilience. Given that preserving existing habitat is often much less expensive than restoring lost or degraded habitat[40], the role of policies and governance frameworks that protect extant habitat is critical to maintain the ecosystem services provided by coasts. Integrated policy reforms and governance improvements should consider the full range of pressures driving coastal health and the interactions between different interventions and ecosystem components. As the interface between land and water, coasts are often characterized by conflicting uses, for example agriculture versus aquaculture, especially for the poor. Public sector management can involve many fragmented institutions with overlapping jurisdictions. Due to this complexity, adopting a phased-approach when designing governance interventions can focus on creating or strengthening coordination mechanisms, decision-support tools, and planning instruments such as coastal setbacks.

Integrated coastal zone management also requires robust data and information, which often do not exist, are not accessible or are not of suitable quality. Enhancing coastal resilience requires data that covers large geographic areas, but is also of high resolution, particularly for small islands. Given seasonal variation in much of the relevant data, temporal scale is also an important issue. In addition, an integrated approach requires data from separate and discrete disciplines. For example, integrated approaches that focus on both people and nature require data from the social and natural sciences. Finally, for data to inform decision-making, it needs to be accessible and timely, while tools and processes are needed to interpret and translate the data into information such as hazard maps. Fortunately, many institutions and companies are leveraging technology, the 'internet of the things' and big data sources to collect new information faster and more easily.

However, if basic human resource constraints are not addressed, even the most innovative public management will not be effective. For example, monitoring and enforcement of coastal and marine development are common institutional weaknesses. Designing and implementing integrated coastal management approaches that enhance coastal resilience requires specialized skill sets such as facilitation of participatory processes, systems thinking, oceanography, engineering, and disaster risk management.

What Does This Look Like?

Across the globe, there are a variety of initiatives attempting to implement nature-based solutions and integrated coastal zone management. In the United States, especially along the Mid-Atlantic coastline "living shorelines" are being implemented, particularly in coastal areas without strong wave action and for private property owners[41]. This includes the United States' first-ever living shorelines permit[42], which incentivizes adoption of nature-based solutions by reducing permit approval time. In the Netherlands, the "Building with Nature" program is an innovative partnership between government, the private sector, and academia[43]. A hallmark project of this partnership is the Delfland Sand Engine, a large-scale experiment in concentrated beach nourishment that was designed to use wind and currents to protect the coast for 20 years. Another consortium, the Natural Capital Project, has developed tools to assess the contribution of coastal ecosystems in a spatially explicit and participatory manner[44], which supported the design of Belize's Integrated Coastal Zone Management Plan[45] and produced the first United States map of risk-reduction due to natural habitats. In 2016, the World Bank's Wealth Accounting and the Valuation of Ecosystem Services Partnership released guidelines and recommendations for measuring and valuing the protective services of mangrove and coral reefs[46], which fills a critical knowledge gap in the advancement of incorporating ecosystem services into national accounting.

At the IDB, we are working with partners in the public sector to incorporate natural capital, climate change, and disaster risk management into sustainable economic development in Latin America and the Caribbean. Our work in coastal management includes environmental governance and policy, innovative investment opportunities, and sustainable development planning. Governments and communities are increasingly interested in technical assistance, knowledge, and financial products to support building with nature, integrated planning, and climate adaptation

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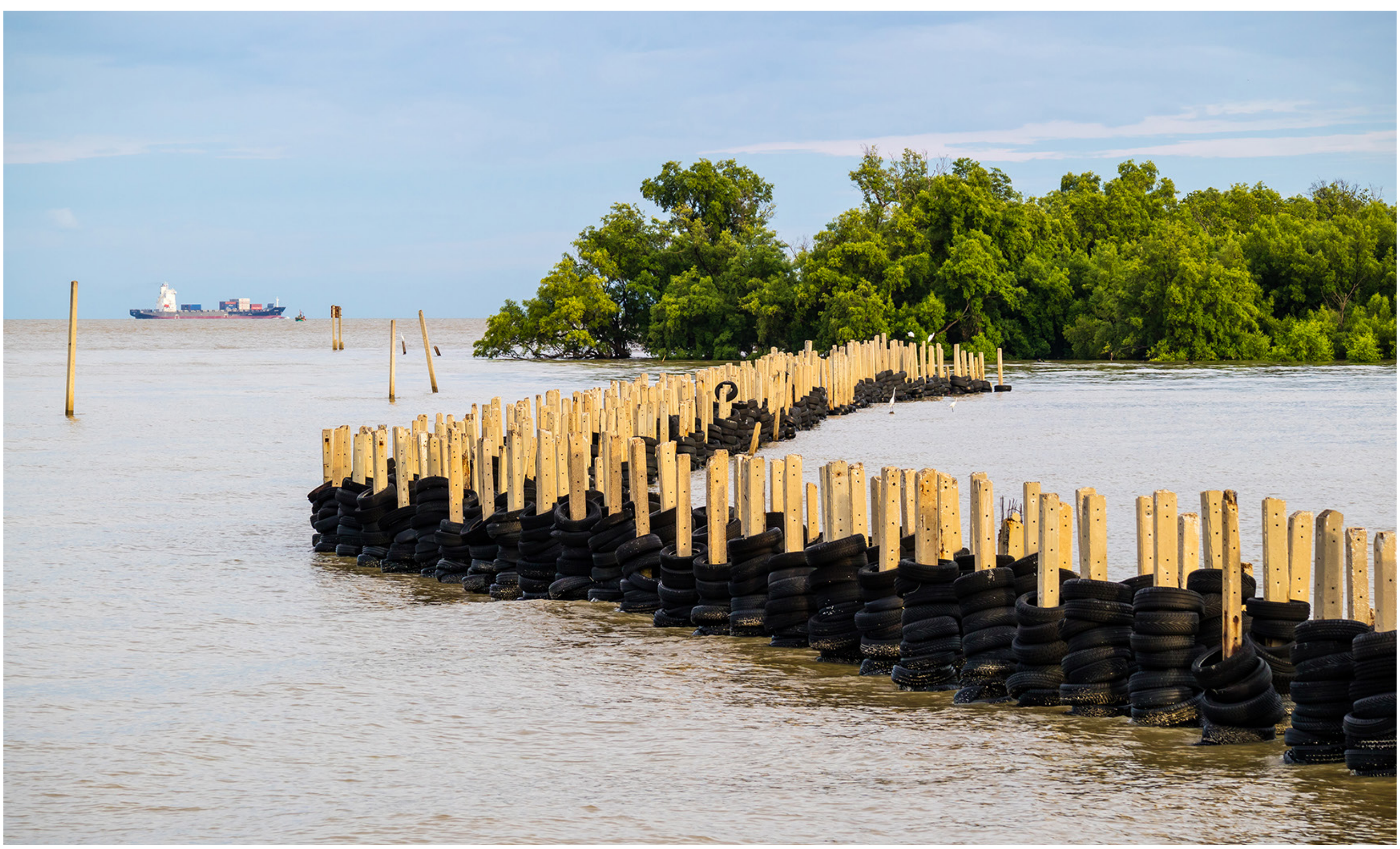
to enhance coastal resilience. For some, particularly small island developing states, these are questions of survival in the context of a rapidly changing climate.

The IDB has supported a phased approach that starts with a few select issues clearly linked with the national economy (e.g., shrimp aquaculture in Ecuador, beach erosion in Barbados, protected areas and biodiversity in Belize) that builds a foundation for coastal resilience over the long term. Through grant financing, investment programs, and policy-based loans, the IDB has been particularly involved in coastal infrastructure and tourism and has found that coastal management programs are cost-effective. A recent impact evaluation of one such program, which built off a 30-year collaboration between the IDB and the Government of Barbados, found positive valuations of coastal infrastructure improvements (23% - 30% of tourists were drawn to the beaches due to the improved conditions). In dollar terms, tourists and residents valued the improvements at $51 BBD (per visit to Barbados) and $57 BBD (per year), respectively[47].

The integrated approach has focused on baseline data and research, information management and decision support tools, policy reforms, and science-based coastal protection infrastructure. Outcomes are measured in terms of improved disaster risk management, adaptation to climate change, and increased livelihoods opportunities. For example, in Belize, the approach has been incorporated into a sustainable tourism program, which includes emerging coastal tourism destinations. This work also has resulted in a series of climate change and environmental policies in Trinidad and Tobago, establishment of a permanent Coastal Zone Management Unit in Barbados and an ecosystem-based master plan for development in the largest island of The Bahamas. The IDB is currently focused on filling knowledge gaps through the design of a tool to measure and monitor public sector management of coasts, a strategy for mobilizing climate finance for coastal management, and establishment of a regional center of excellence for coastal natural capital in the Caribbean.



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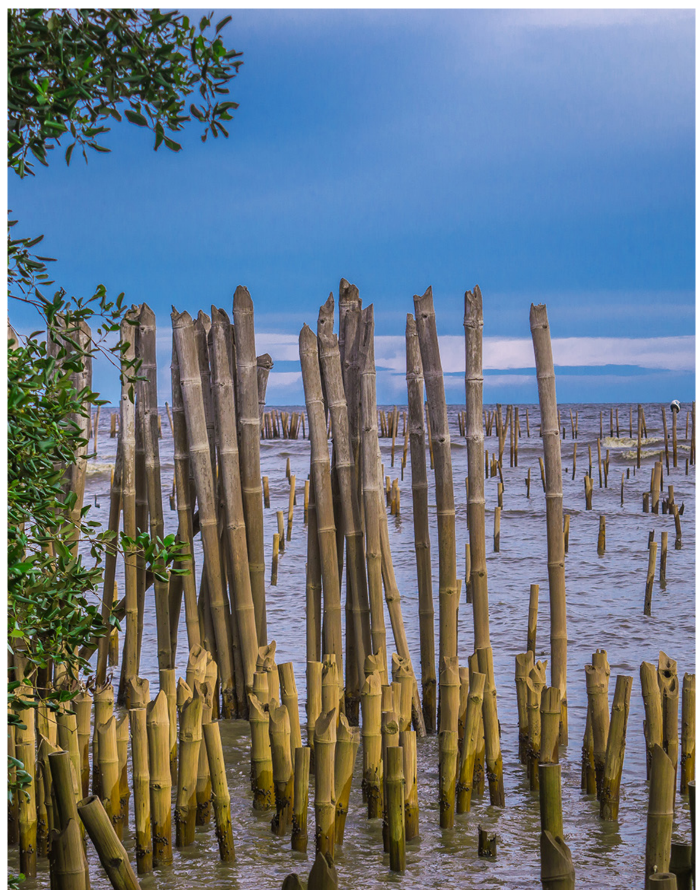
The Way Forward

Across the IDB, coastal resilience is relevant to our work on biodiversity and the environment; sustainable landscapes, islands and infrastructure; climate-proofing coastal cities; and implementation of countries' commitments under the Paris Agreements and Sustainable Development Goals. Advancing this approach also embraces the IDB's commitment to multisectorality and sustainability through investment opportunities in biodiversity, urban planning, tourism, disaster risk management, agriculture, and water and sanitation. In addition, new financial instruments such as Loans Based on Results provide opportunities to support governance and policy reforms to enhance coastal resilience, such as coastal setbacks, innovative permitting and land-use policies, and coastal zone management frameworks. To effectively implement this approach, there are three key opportunities to address: (1) increasing capacity, (2) scaling-up solutions, and (3) expanding processes for engagement, outreach, and collaboration.

There is a need to build capacity both in terms of technical skills and the evidence-base required to design and evaluate projects. Bolstering technical skills requires building capacity of policy makers, coastal engineers, and ecologists. Building the evidence base requires filling regional and national information gaps on coastal ecosystem services and risk, collecting data on the effectiveness of nature-based solutions, estimating the benefits of natural coastal infrastructure, and predicting with precision coastal protection benefits of natural systems. Collecting and disseminating data from the Region could have additional value-added because the Region is currently under-represented in the literature.

There is also a need to scale up solutions to match the scope of the challenge. A key opportunity for scaling up includes expanding partnership with the private sector to accelerate innovation. Innovative technology also has great potential to accelerate the uptake and implementation of this approach and is key area for collaboration with the private sector. For example, satellite and drone-derived data are revolutionizing the collection of important information.

Increased collaboration and participatory processes that include stakeholders from different sectors, particularly the private sector, is also an opportunity for growth. Increased awareness cultivated through strategic and programmatic communications is a key component of this. There is increasing evidence that engaging communities and decision-makers is central to project success. Yet, there is still an opportunity to improve the understanding of how to do this, incorporate these lessons into project design, and create monitoring and evaluation frameworks to share knowledge and derive lessons learned. Given the global need to adapt and mitigate climate change, transferring experiences from the Caribbean to Central and South America is a clear opportunity for the future. Together with national authorities, regional organizations, and the private sector, we can work to achieve resilient communities, economies, and ecosystems that drive sustainable and inclusive growth.



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Endnotes

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