

KEY POINTS

- The Republic of Maldives is one of the most biodiverse countries in the world, yet it is among the most vulnerable to climate change. The country needs to ensure the sustainable management of natural resources in spite of the impacts and consequences of climate change.
- The government's environmental management and resource conservation efforts that began in the early 1990s have been constrained by a lack of relevant data and information.
- This brief presents the development of a geospatial database and maps to help Maldives (i) assess disaster risks and impacts; (ii) reduce these by strengthening the design of programs and policies; and (iii) mainstream climate change adaptation in development planning.
- A geospatial database on coastal and marine ecosystems that includes climate risk assessment information makes it feasible to screen for climate risks in development projects and programs at national and subnational levels.

National Geospatial Database for Maldives to Mainstream Climate Change Adaptation in Development Planning

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BACKGROUND

Maldives is a developing state composed of 26 natural atolls with about 1,192 small coral islands spread over roughly 90,000 square kilometers in the Indian Ocean. The country is divided into 20 administrative regions, each with a local administrative authority governed by the central government. With some of the world's most beautiful beaches, Maldives has relied on high-end tourism to expand its economy over recent decades and gained middle-income status with the highest per capita income in South Asia.¹

Maldives is characterized by extremely low elevations and, as one of the most geographically dispersed countries in the world, it is among the most vulnerable to climate change. Recognized as the seventh-largest in the world, the country's coral reefs and associated ecosystems are major natural resources and key foundations for food security and means of livelihood. They are highly dynamic, as directional shifts within the shoreline are dependent on seasonal conditions. But they are also extremely vulnerable to human activities and infrastructure development projects.

¹ ADB. 2019. Asian Development Bank Member Fact Sheet: Maldives. Manila.

The increase in population and the rise of tourism have resulted in an increase in demand for housing and accommodations. In 2004, 11.7% of the inhabited islands exceeded their carrying capacities—73% had buildings less than 100 feet away from the shoreline and 2% had buildings right at the shoreline.²

The biophysical and socioeconomic impacts of development can be exacerbated by climate change. In Maldives, socioeconomic impacts of development include land loss and beach erosion, infrastructure damage, and destruction of coral reefs, aside from food and water insecurity, health risks, and other economic issues. All this calls for the sustainable management, conservation, and use of the country’s limited natural resources.

Upon the request of the Government of Maldives, the South Asia Department (SARD) of the Asian Development Bank offered to support the project “Establishing a National Geospatial Database for Mainstreaming Climate Change Adaptation into Development Activities and Policies” through the technical assistance (TA) Action on Climate Change in South Asia (2013–2018). Implemented by the Ministry of Environment (MOE) of Maldives, the project focused on coastal and marine biodiversity and infrastructure.³ The main activities involved (i) designing a geospatial database on coastal and marine ecosystems to enable climate risk screening of development projects and (ii) pilot-testing SARD’s climate risk screening methodology on selected development projects.

This policy brief summarizes the consultants’ reports from the ADB-supported country initiative.

INSTITUTIONAL ARRANGEMENTS, POLICIES, AND REGULATIONS ON COASTAL RESOURCES MANAGEMENT

The project identified two issues critical to natural resource and environmental management in Maldives:

- The lack of systematized and readily available data on natural resources and limited related institutional and human resource capacity
- The absence of proper natural resource management programs or plans, especially for coastal resources

Without a law on coastal protection and management, the compounding situation involves a fragmented institutional framework in which different institutions at the local and national levels have overlapping roles and responsibilities.

The Government of Maldives, however, has expressed its commitment to develop environmental policies and regulations for sustainable marine and coastal resources management.

Governing policies, plans, and programs. To promote climate change resilience, Maldives has incorporated relevant measures in key policies:

- The Maldives Climate Change Policy Framework guides development activities based on seven principles: climate leadership, intergenerational equitability, mainstreaming climate change action, relevant international commitments, multinational partnerships, technology transfer, and climate resiliency.
- The National Adaptation Programme of Action 2007 comprehensively describes the country’s key climate vulnerabilities. It presents the policy framework for climate change adaptation to sustain and ensure the resilience of natural and social systems in Maldives. It further emphasizes priority actions for wetland conservation, waste management, coastal erosion, and sea inundation.
- The Strategic National Action Plan for Disaster Risk Reduction and Climate Change Adaptation 2010–2020 acknowledges the threats posed by beach erosion, sea level rise, and saltwater intrusion. It aims to build resilient communities through empowerment and disaster risk reduction and management.
- The National Biodiversity Strategy and Action Plan 2016–2025 aims to protect and manage representative ecosystems and resources in Maldives, recognizing the need to relieve, if not resolve, competing demands and pressures against them. This includes a target of minimizing, if not eliminating, pressures on coral reefs and other vulnerable ecosystems posed by climate change and local anthropogenic activities by 2025.

Legislative framework. The government also enacted a number of laws and regulations governing environmental protection and management in Maldives (Table 1).

DESIGNING THE COASTAL AND MARINE GEOSPATIAL DATABASE

Marine and coastal environments play a vital role in regulating the global climate via carbon and water cycles. Rising temperatures and sea levels, ocean acidification, increases in storm severity, and other climate change scenarios and extreme weather events represent significant pressures on coastal and marine ecosystems. A comprehensive geospatial database of these ecosystems’ features and services, therefore, needs to be established in Maldives.

² Government of Maldives, Ministry of Environment and Construction. 2004. *State of the Environment Report 2004*. Malé.

³ The Ministry of Environment was formerly the Ministry of Environment and Energy.

Table 1: Environmental Protection Laws and Regulations in Maldives

Environmental Protection Law	Year Enacted	Purpose/Objective
Environmental Protection and Preservation (EPP) Act	1993	Established a framework to protect and preserve the country's natural environment and resources; has provisions on environmental advice and policy formulation, biodiversity conservation, and environmental impact assessment
Regulations on Sand and Aggregate Mining	2000	Restricts sand extraction in lagoons and prohibits it in beaches; implemented by the Ministry of Fisheries, Marine Resources, and Agriculture
Regulations on Valuing Damages to the Environment	2011	Prohibits and limits activities that contravene the EPP Act to avoid any overlap or duplication and apply a framework for determining environmental damages; provides damage categories, units for measuring impact, and the valuation of specific damages, depending on size and scale
Environmental Impact Assessment Regulations	2012	Guides the process of conducting environmental impact assessments in the country
Dredging and Reclamation Regulations	2013	Requires projects with dredging and reclamation components to produce scaled maps of an island, before and after a proposed intervention, and outline a minimum buffer zone between reef and shorelines as well as around reefs; implemented by the Environmental Protection Agency
Waste Management Regulations	2013	Provides comprehensive guidelines on collecting, storing, transporting, and managing solid waste and hazardous wastes; prohibits waste disposal in protected areas identified by the EPP Act—mangroves, lagoons, coral reefs, sand banks, beaches, coastal vegetated areas, harbors, parks, and roads

Source: Asian Development Bank.

A geospatial database is a common data storage and management framework within a geographical information system (GIS). In Maldives, it can help

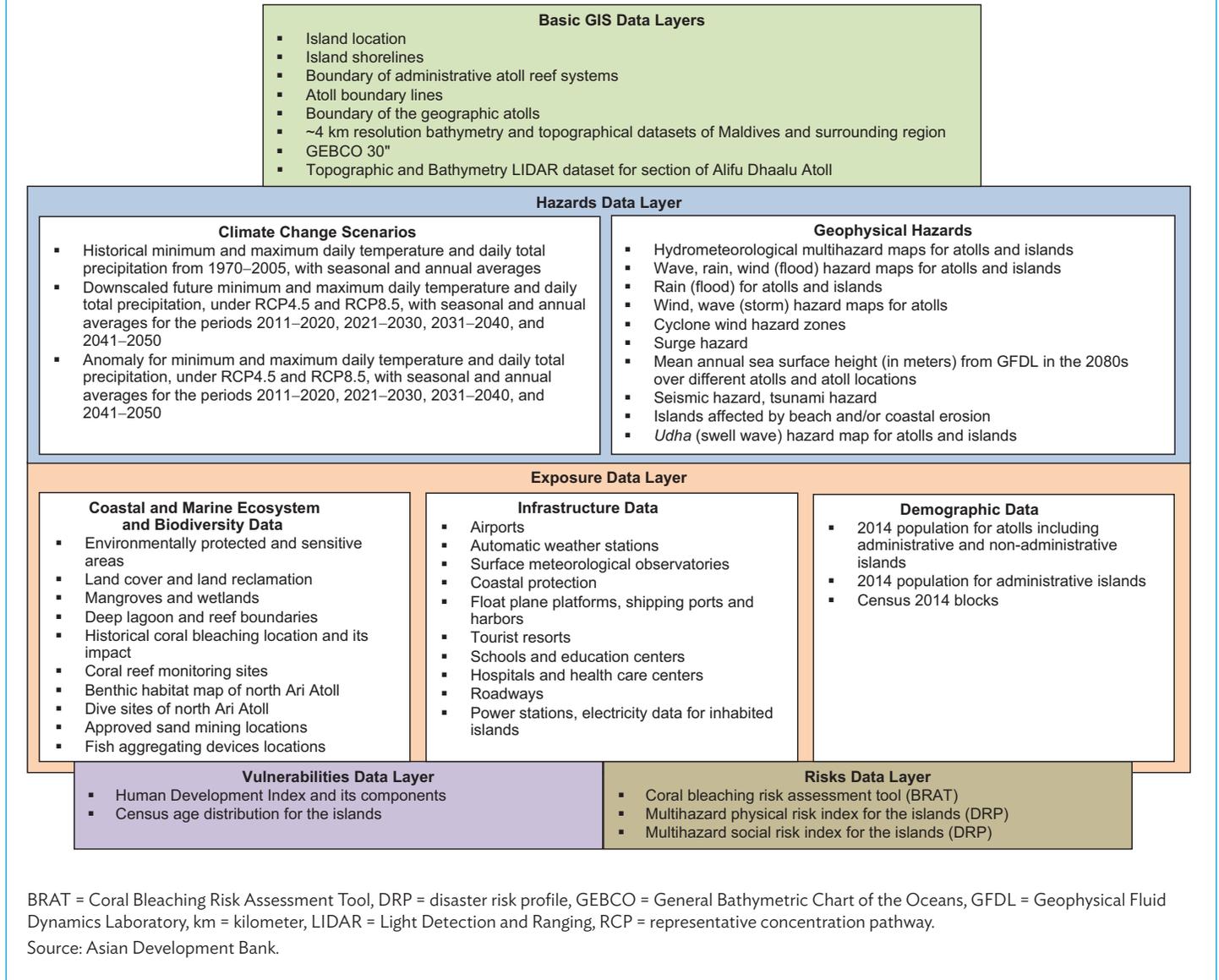
- demonstrate and communicate the importance of ecosystems and their interrelationships;
- support the effective monitoring of ecosystem changes;
- guide national development plans, policies, programs, and project appraisals;
- set priorities in plans within a sector or across different sectors;
- support green national and corporate accounting;
- set a framework to establish market-based instruments, such as taxes, charges, fees, fines, penalties, subsidies, incentives, and tradable permit schemes; and
- determine liability and compensation in environmental litigation.

Establishing a geospatial database on coastal and marine ecosystems that includes relevant climate risk assessment information makes it feasible to screen for climate risks in development projects and programs at the national and subnational level.

The geospatial coastal and marine ecosystems and climate change database prepared for Maldives is a comprehensive data set based on SARD's climate risk screening framework and decision support system. It consists of six subcomponents or data layers on basic GIS data—hazards (climate scenarios and geophysical hazards), exposures, vulnerabilities, risks, and impact, or "HEVRI":

- **Hazards (H)** or threats are events or conditions that may cause harm (i.e., loss and damage) to a system (e.g., community, project).
- **Exposure (E)** is the extent to which elements and spatial units are affected by climate, geophysical, ecological, and/or artificial hazards.
- **Vulnerability (V)** is the degree to which elements and spatial units will be responsive to, may recover from, or will be able to cope with and adapt to hazards.
- **Potential risk (R)** or likely impact of a climate event on a system is a function of hazards, exposures, and associated vulnerabilities. This relationship of variables may be expressed as: $R \sim f(H, E, V)$.
- **Impact (I)**, as a component, gathers actual archival spatial data sets that enable weighting of HEVs in the future.

Figure: Geospatial Database Data Layers on Coastal and Marine Ecosystems in Maldives



The figure details the data and information acquired on the coastal and marine ecosystems of Maldives under each geospatial database subcomponent.

Maps of natural hazards in coastal and marine ecosystems were not readily available during activities under ADB’s TA. There were studies on physical, socioeconomic, and human vulnerability,

but most were technical reports rather than spatial data sets and maps. The required maps, spatial data, and information shown in the figure were obtained from government agencies and relevant sources. These were reviewed, processed, and standardized to conform to file naming protocols, metadata, and mapping guidelines established for the regional TA project.⁴

⁴ The Manila Observatory is the regional TA’s clearinghouse for remote sensing and GIS matters, including spatial knowledge development and management for decision support; guidance on and coordination of data gathering and mapping activities in the developing member countries of ADB; setting guidelines; review of maps and associated files; management of SARD’s climate risk screening and decision support system; and development of value-added products and instruments. The Manila Observatory is a nonprofit research institute founded in 1865 and housed at the Ateneo de Manila University in Quezon City, Philippines.

OPERATIONALIZING THE CLIMATE RISK SCREENING AND DECISION SUPPORT SYSTEM IN PROPOSED INVESTMENT PROJECTS

Climate and disaster risk screening or assessment is a systematic process of identifying climate and disaster-related risks in development projects. It evaluates how they may affect a project's life span and efficacy and recommends adaptation options to address significant climate risks, thus sustaining the project's planned benefits. The geospatial database and maps described in the previous section are important inputs enabling localized (project- and site-specific) climate risk screening.

SARD's climate risk screening framework was applied on three environment-related projects in Kulhudhuffushi, Fuvahmulah, and Thinadhoo using the described geospatial database and generated maps. The projects were selected in consultation with the MOE, based on the following criteria:

- geographic dispersion;
- an island's population size;
- type and size of an infrastructure development project;
- proximity to environmentally sensitive areas;
- socioeconomic importance, impact, and needs; and
- frequency and commonalities across projects in Maldives.

Table 2 summarizes the key features of the three development projects and the findings after evaluating them for climate change risks and natural hazards. The most relevant climate risks and hazards were sea level rise, rainfall-induced flooding, storm surge, tsunamis, and *udha* (swell waves). Earthquakes, forest fires, heat waves, and droughts were seen to have low to no impact. The design of the proposed development projects should, therefore, incorporate components and activities addressing those climate risks and hazards found significant.

WAYS FORWARD

The vulnerability of Maldives to climate change and natural hazards could prove detrimental to its pursuit of sustainable socioeconomic development. However, it should be seen as a challenge and opportunity to prepare a master plan that will maximize and sustain development benefits. The aforementioned discussions have shown that geospatial databases and maps are essential in evaluating climate change and associated disaster risks and impacts as well as formulating strategies and options to reduce, if not eliminate, risks.

The following initiatives are necessary to strengthen and expand the preliminary geospatial database established through ADB's regional TA as well as to formalize a climate risk screening and decision support system for Maldives.

Geospatial databases should be given legal status to make their application compulsory in designing investment projects and formulating development policies. For efficiency, existing relevant regulations such as the Environmental Protection and Preservation Act can be amended to incorporate clauses requiring the application of geospatial databases.

The establishment, improvement, and sustainability of the initial geospatial database will also benefit from the following set of actions:

- The Maldives Land and Survey Authority needs to urgently adopt a National Geodetic Datum and a National Projected Coordinate System (National Grid) for mapping via GIS application. The datum transformation methods and parameters must be published to guide data collection and ensure its accuracy.
- Design and introduce a spatial data management policy for Maldives that will address data sharing requirements and arrangements among government ministries, departments, and agencies. This can be initially adopted for investment or development projects under the Public Sector Investment Programme.
- Put together a set of standards and specifications for identifying, collecting, and managing spatial and other relevant data and information to guide the content, design, and structure of databases. A similar set of protocols will also be useful in preparing the associated maps, especially in terms of meeting data and information requirements for policy and decision-making and development planning and implementation.
- Design geospatial databases to allow for ample flexibility for wider practical application and better utilization that can support similar assessment activities and/or monitoring exercises, such as the environment impact assessments, resource surveys and inventories, and socio-environmental monitoring. Current regulations on environmental monitoring activities could be amended to ensure that data collection and processing follow GIS standards and protocols.

Promoting the use of remote sensing GIS-based databases in Maldives will require building or enhancing institutional and human resource capacities in key government agencies (e.g., Environmental Protection Agency, Maldives Land and Survey Authority, Marine Research Institute, MOE, and National Disaster Management Centre) and other relevant stakeholders including nongovernment organizations and research and academic communities.

Table 2: Initial Climate Risk Screening Summary Findings on Three Development Projects in Maldives

Island and Brief Description	Project and Brief Description	Climate Risks and Natural Hazards (low, medium, moderate, high levels)	Potential Adaptation Options	Proposed Next Steps
<p>Kulhudhuffushi Island, eastern peripheral reef of South Thilhummathi Atoll</p> <p>The island is the most populated island in the north of Maldives and is being developed as an urban center.</p>	<p>Kulhudhufushi Land Reclamation Project, to reclaim 35 ha of shallow reef flat (lagoon) on the island’s western shoreline</p>	<p>Climate risks</p> <ul style="list-style-type: none"> • Rainfall-induced flooding (high) • Storm surge (high) • Cyclone winds (medium) <p>Natural hazards</p> <ul style="list-style-type: none"> • Flooding • <i>Udha</i> (swell waves) • Sea level rise (high) • Tsunamis (high) 	<p>The high risk of sea level rise and storm surge calls for coastal protection structures that consider the projected maximum storm tide of about 2.3 m above mean sea level.</p>	<p>Conduct a detailed assessment of risks posed by flooding due to changing land elevations. Study potential drainage system within the reclaimed area. Analyze potential coastal erosion issues that may arise from the planned development.</p>
<p>Fuvahmulah Island, 424 ha, considered a single island atoll (Gyanivayani Atoll)</p> <p>It has wetlands, lakes, tropical woodlands, marshy areas, and fertile soils for agriculture.</p>	<p>Fuvahmulah Coastal Protection Project, to construct 2.6 km of rock armor seaward onshore breakwater to address impending severe coastal erosion</p>	<p>Climate risks</p> <ul style="list-style-type: none"> • Flooding induced by wave winds and rains (high) • Storm surge (high) • Cyclone winds (low) <p>Natural hazards</p> <ul style="list-style-type: none"> • <i>Udha</i> (swell waves) • Sea level rise (high) • Tsunamis (moderate) 	<p>The design of coastal protection structures should consider that maximum storm tide or surge can reach 2.3 m above mean sea level in the eastern islands of Maldives.</p>	<p>Conduct further detailed assessments of potential coastal erosion and related issues (e.g., sedimentation, saltwater intrusion, degradation of water quality) that may counter development.</p>
<p>Thinadhoo Island, located in the Gaafu Dhaalu Atoll, on the western ridge of Huvadhoo Atoll</p> <p>The island, which has reclaimed several times, spans 118.8 ha with a population of 5,268 as of 2014. Its outer ridges are higher than the inner center, forming an inward slope.</p>	<p>Thinadhoo Drainage and Groundwater Recharge Improvement Project</p>	<p>Climate risks</p> <ul style="list-style-type: none"> • Flooding induced by wave winds and rains (high) • Storm surge (medium) • Cyclone winds (low) • Heat wave (low) <p>Natural hazards</p> <ul style="list-style-type: none"> • Earthquake (moderate) • <i>Udha</i> (swell waves) • Sea level rise (high) • Tsunamis (high) 	<p>The water table of the island is very low, which might require pumping out large amounts of water (dewatering) during the construction period. This will, however, impact on the availability and quality of (potable) groundwater in the island.</p>	<p>At the time of activities under the Asian Development Bank’s technical assistance, a road development project was scheduled to start. The drainage development project must be executed simultaneously with the road development project.</p>

ha = hectare, km = kilometer, m = meter.

Source: Asian Development Bank.

Capacity building will include providing critical spatial databases, hardware and software, personnel, systems protocols, and curriculum development, and then tapping opportunities for skills development (degree or non-degree training), among others. This will also encourage and strengthen interagency collaboration and

coordination for planning, monitoring, and evaluating development initiatives on the local, regional, and national levels, including those meant to address the impact and consequences of changing climate patterns and extreme weather events.

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