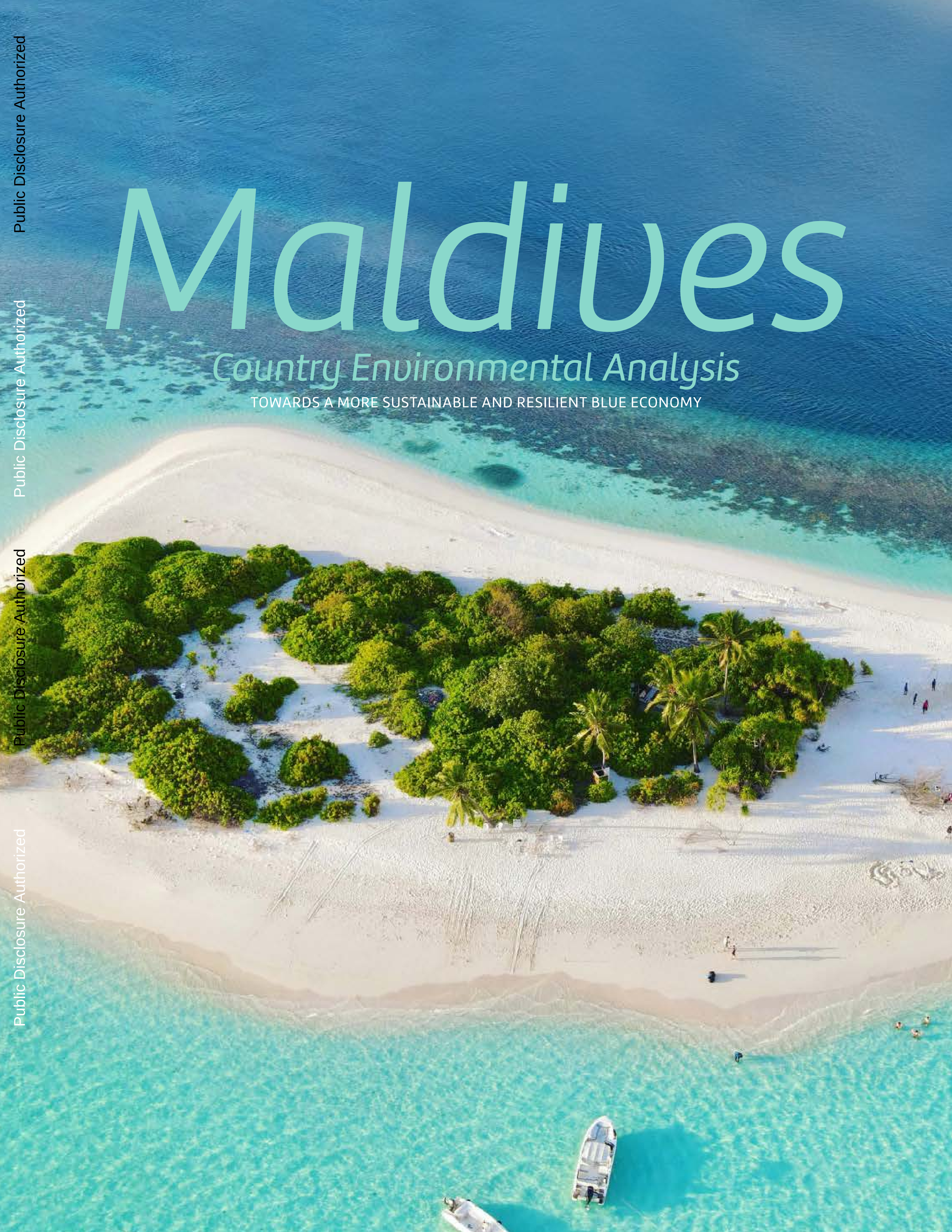
Maldives

Country Environmental Analysis

TOWARDS A MORE SUSTAINABLE AND RESILIENT BLUE ECONOMY



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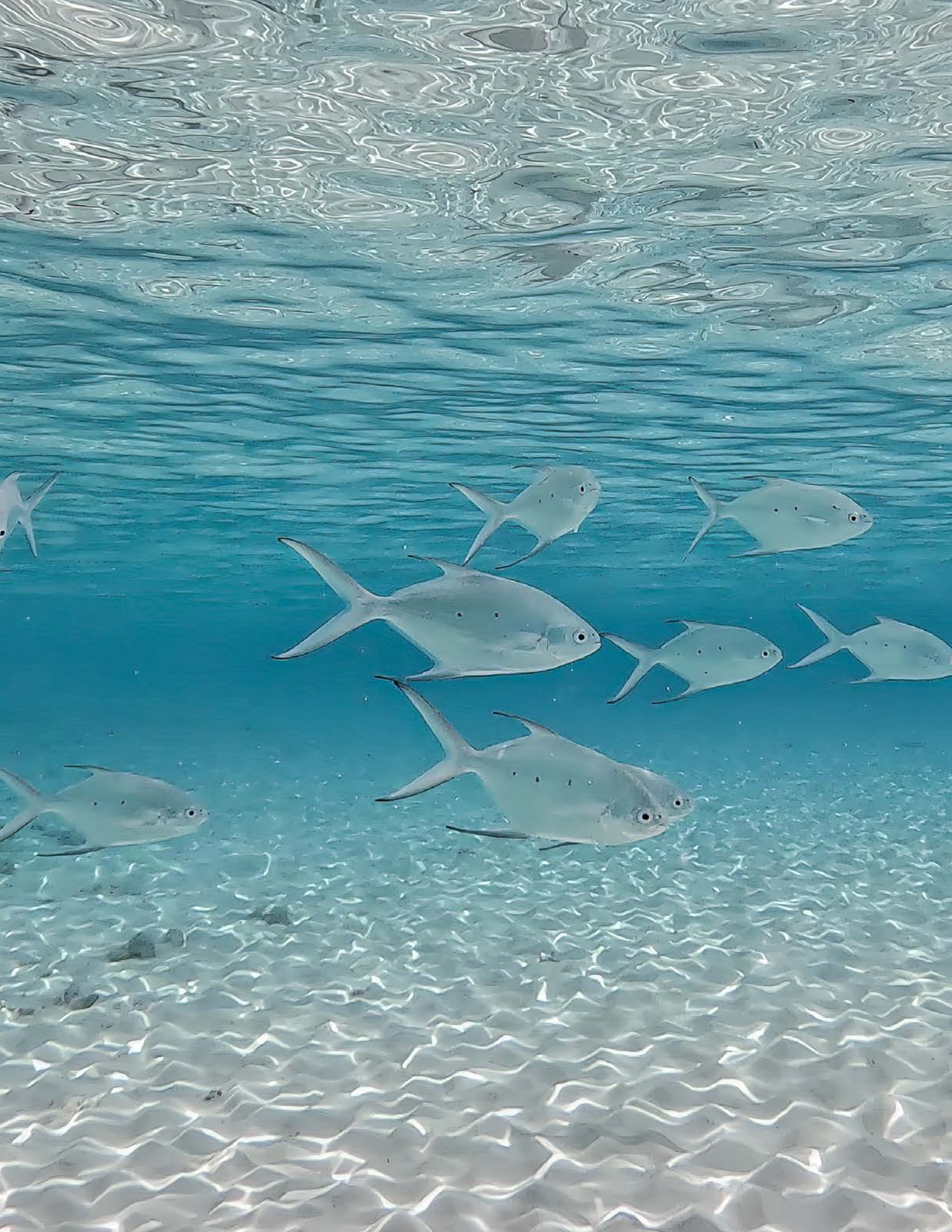

Executive Summary

Maldives' past development path has led to significant improvements in physical capital (infrastructure and related services), and human capital (such as health and education). Over recent decades, the Maldives has witnessed remarkable economic growth. The nation doubled its real income per capita within a 20-year period, transitioned from low to middle-income status, and substantially reduced poverty. This economic growth path was complemented by considerable advancements in infrastructure – including developments in roads, harbors, and ports, as well as ensuring wider access to essential utilities like electricity, water, sanitation, and the internet. From 1966 to 2022, the Maldives inaugurated 17 airports and, achieved universal electricity access by 2014 (from 84% in 2000), showcasing its significant growth in produced capital. The country's human capital has also seen marked progress, with notable achievements in key indicators within education and healthcare. For instance, life expectancy more than doubled from 1960 to 2020 and child mortality and maternal mortality drastically decreased. On the education side, educational attainment has significantly increased over the last decades and more than 9 in 10 people are literate in English.

Maldives' past development path has placed pressure on its blue natural capital (marine and coastal ecosystems). In addition to the cost to natural capital, there has also been a deterioration in fiscal and debt stability, due in parts to the financing of the infrastructure investments. Environmental degradation threatens key economic pillars like tourism and fishing. Moreover, natural capital is the first line of defense against disasters and climate change, especially sea level rise. Against this backdrop, the CEA of the Maldives documents the main sustainable natural resource and environmental management challenges and provides recommendations for transitioning to a more sustainable, resilient, and inclusive Blue Economy.

Maldives' past development path has led to significant improvements in physical capital, and human capital but has placed pressure on its blue natural resources.

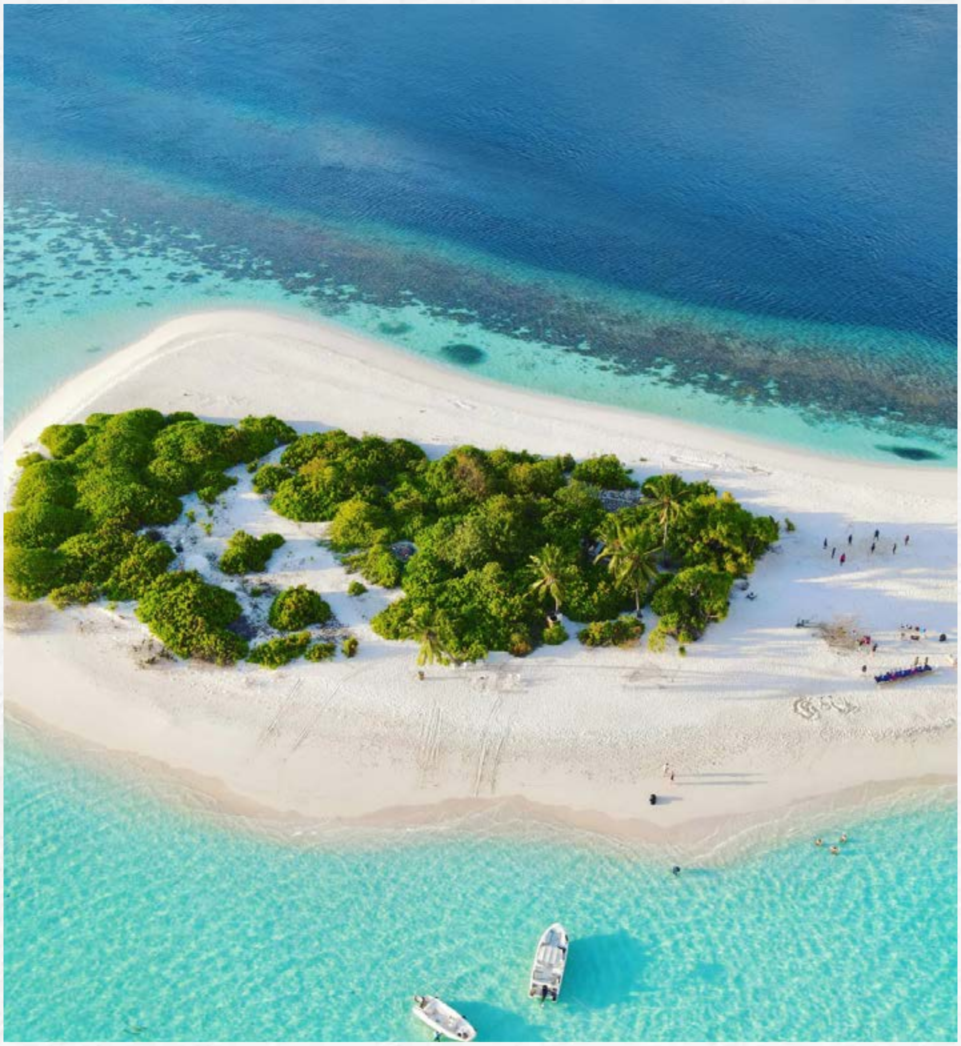

Photo Description: An island in the Maldives © World Bank

Natural Capital, and primarily Blue Natural Capital, is the foundation of the Maldives' economy. The Maldives is a country with a remarkable biodiversity, with 1100 fish species, sharks, marine turtles, dolphins, whales, and a large variety of corals, mangroves, and seagrasses.

Natural Capital, and primarily Blue Natural Capital, is the foundation of the Maldives' economy. The Maldives comprises 26 natural atolls in the Indian Ocean, together constituting 1192 coral reef islands. The island nation consists of 99 percent of water, and the archipelago's islands are surrounded by white sandy beaches and turquoise blue waters teeming with corals. The Maldives is a country with a remarkable biodiversity, with 1100 fish species, sharks, marine turtles, dolphins, whales, and a large variety of corals, mangroves, and seagrasses. The tourism and fisheries sectors, both contributing directly to about half of the GDP-value add and jobs, critically depend on these natural assets. Tourists from all over the world are drawn to the Maldives for its underwater beauty and beaches. Surveys indicate that about 80 percent of visitors say they come for the beaches, while more than 60 percent say they come for the underwater attractions. The profitability of Maldivian fisheries is contingent upon the health of deep-sea fish stocks, particularly skipjack and yellowfin tuna, as well as reef and bait fish stocks, which are directly influenced by the well-being of coral reef ecosystems. The Maldives' economy thus critically depends on Blue Natural Capital.

Coral reefs are significant for the country's coastal resilience and continued existence. Without coral reefs, the Maldives would incur additional annual flood damages amounting to about 8 percent of the country's GDP.

Natural Capital is the foundation of the Maldives' resilience. Coastal ecosystems protect the Maldives' people and infrastructure against various coastal hazards, including sea-level rise (SLR) and floods. Coral reefs are particularly significant for the country's coastal resilience and continued existence. Without coral reefs, the Maldives would incur additional annual flood damages amounting to about 8 percent of the country's GDP. More importantly, the sand produced by coral reefs is essential for the habitability of the Maldives. Virtually all the sediments that form the islands come from corals and algae. The ability of the nation to adapt to the future sea-level rise is heavily dependent on this ecosystem service, and whether the new sand amounts produced and deposited are enough to outpace SLR. Over the past decades, the islands have been able to adjust to average mean SLR. Despite an average SLR of about 3-4 mm per year over the past few decades, very few Maldivian islands (less than 3 percent) have experienced a decrease in surface area over the past two decades. The main question is whether accelerated rates of SLR in the future will outpace the national island formation process and whether corals can adapt to the changing ocean temperatures.

Photo Description: A reef that has experienced bleaching in the Maldives © The Ocean Agency

While only present in small patches, mangroves contribute to stable shorelines and navigation channels and prevent coastal inundation. Seagrass meadows, the most extensive marine vegetated ecosystem in the Maldives, stabilize bottom sediments and reduce wave energy. These stabilization services reduce the need for beach renourishment and dredging. Mangroves are also important buffers against catastrophic flooding caused by tidal waves and cyclones. Therefore, Natural Capital not only drives economic development in the Maldives but also plays a vital role in enhancing the country's coastal resilience.

Maldives' Natural Capital is degrading due to four primary reasons: (1) coastal development, (2) ocean pollution, (3) natural resource extraction, and (4) ocean heating (which is exacerbated by climate change).

Maldives' Natural Capital is degrading due to four primary reasons: *(1) coastal development, (2) ocean pollution, (3) unsustainable resource use, and (4) ocean heating (which is exacerbated by climate change).*

Photo Description: An Island being developed for inhabitation in the Maldives. © Juergen Rudorf

Current coastal development practices threaten natural capital as the foundation of the Maldives' economy and resilience. Coastal developments have greatly enhanced economic productivity and incomes, thus benefiting local lives and livelihoods.

Current coastal development practices threaten natural capital as the foundation of the Maldives' economy and resilience. Coastal developments have greatly enhanced economic productivity and incomes, thus benefiting local lives and livelihoods. Significant investments have been made in port, harbor, dredging, and land reclamation projects, costing about 4 percent of public expenditures, over the last decade. There are harbors on virtually all inhabited islands and airports in 17 administrative atolls, improving connectivity and driving economic growth. However, these coastal developments have come at a considerable cost to the natural capital of the Maldives. Since 2002, more than 10 square kilometers of lagoon and reef area have been altered for land reclamation, representing roughly 3.4% of the entire country's land area.

Coastal developments in the Maldives, particularly the construction of harbors and other coastal infrastructure, have caused notable physical damage to coral reefs. These developments disrupt the coastal equilibrium, accelerating erosion rates and causing coastlines to retreat rapidly, especially at areas adjacent and down-current from the coastal infrastructure site. Coastal infrastructure developments undermine islands' natural defenses, making them more vulnerable to sea-level rise and storm surges. As a result, there's a pressing need for additional coastal protection measures to safeguard both the natural environment and the communities that rely on them.

The physical measures chosen to protect the coasts from SLR and coastal flooding mostly rely on gray infrastructure solutions. Since the 1970s, the

Maldives has predominantly chosen 'gray' infrastructure like seawalls and breakwaters for coastal protection ...Gray infrastructure can often be maladaptive, as it leads to significant unintended side effects, such as destabilizing sediment transport processes.

Maldives has predominantly chosen 'gray' infrastructure like seawalls and breakwaters for coastal protection, on both inhabited and resort islands. Between 2004 and 2016, 45 inhabited islands implemented hard engineering solutions, compared to just two using 'green' approaches (both picked the most conservative green solution, which is beach nourishment). Gray infrastructure can often be maladaptive, as it leads to significant unintended side effects, such as destabilizing sediment transport processes. Notably maladaptation prevents reef islands from adapting to sea-level rise and increases the likelihood of being locked into further reliance on gray solutions like seawalls, revetments, and breakwaters. To avoid exacerbating maladaptation, it is important to explore nature-based solutions such as artificial reefs and mangrove restoration. A systematic piloting of nature-based solutions is needed. Properly implemented, green approaches can help preserve natural capital, enhance coastal resilience, and limit the adverse impacts of coastal development.

Photo Description: A top the mound of waste at Thilafushi, Kaafu Atoll © World Bank

Ocean pollution from both solid and liquid waste continues to be a challenge. Significant improvements in Solid-Waste Management (SWM) have been made over the last decade, as reviewed in detail in this report. However, solid waste leakage continues to threaten the quality of coastal and marine ecosystems, and therefore a continued push to improve SWM is important. About 80 percent of the resorts interviewed by this CEA reported that their islands are polluted with

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The Maldivian tuna fisheries sector is sustainable, but the sustainability of coastal fisheries is uncertain.

plastic waste. Solid waste (including fishing lines) is also regularly found in the water and on coral reefs. Microplastic concentrations in some Maldivian marine ecosystems are like those in highly polluted sites around the world and have been found to contaminate the majority of corals and fish in select Maldivian locations where samples were taken and studies were carried out. Wastewater from several local islands is currently discharged into the oceans without adequate secondary treatment, as there are only a few operational sewage treatment plants. However, there is very little understanding of the impact of liquid waste on marine and human health as there is practically no measurement of water pollution in the country, let alone an assessment of the environmental health consequences.

Photo Description: Fisherman, with pole and lines standing over the vast haul of freshly caught tuna, Maldives © World Bank

The Maldivian tuna fisheries sector is sustainable, but the sustainability of coastal fisheries is uncertain. Tuna in the Maldives is sustainably caught by local fishers using pole-and-line and handline methods, primarily within 12 nautical miles of the shore. Furthermore, the country adheres to internationally

Climate change threatens to undermine the future stability of reef islands...Ocean heating during El Niño events, which occur every three to five years. is particularly detrimental to coral reefs.

established fish quotas set by the Indian Ocean Tuna Commission (IOTC) to prevent overfishing and depletion of tuna species. In contrast to the tuna fisheries sector, the sustainability of coastal reef-based fisheries is uncertain, often due to lack of data and relevant analysis. The rising extraction of reef fish for tourism-related consumption and the consistent removal of live bait from the same coastal areas are thought to exert significant pressure on the health of coastal reef ecosystems. One potential solution to alleviate this pressure is to diversify target species and to enhance efforts towards aquaculture. The current Marine Protected Areas (MPA) network in the Maldives covers only a small portion of the ocean waters, and the enforcement and existence of management plans for these areas are lacking. More research and monitoring programs are needed to better understand the sustainability issues in coastal fisheries, some of which are already planned to be undertaken during the coming years by the MMRI and the MoFMRA.

Photo Description: A white bleached coral on a coral reef in the Maldives during a global bleaching event as a result of warming ocean temperature © The Ocean Agency

In significant bleaching events in 1998 and 2016, coral cover declined from around 70 percent to 7–25 percent, from which the corals have significantly (although not fully) recovered.

Climate change threatens to undermine the future stability of reef islands. Ocean heating during El Niño events, which occur every three to five years, is particularly detrimental to coral reefs. In significant bleaching events in 1998 and 2016, coral cover declined from around 70 percent to 7–25 percent from which the corals have significantly (although not fully) recovered. Climate change contributes to a shortening of the intervals between bleaching events and their increasing severity, which hinders the ability of coral reefs to recover. Human pressures on reef ecosystems further exacerbate the risks. Coastal development, pollution, and fishing make corals more vulnerable to bleaching events. Moreover, even though marine ecosystems are resilient, it remains unclear whether they can adapt swiftly to the rapidly changing ocean conditions. As coral reefs are crucial for the Maldives' adaptation to sea-level rise, the combined effects of future ocean heating events and anthropogenic pressures pose a significant threat to the future of the country's reef islands.

8 KEY RECOMMENDATIONS

Pathways for a more sustainable and resilient Blue Economy

The CEA presents detailed sets of recommendations under each (sub) chapter on how to move towards sustainable management of blue natural capital and get a better handle on the four main challenges identified, including maladaptive coastal development, pollution, unsustainable natural resource use, and climate change.

The recommendations, summarized below, aim to provide a roadmap for the Maldives to navigate towards a more sustainable and resilient future. Emphasizing a holistic approach, the CEA advocates for strengthening local capacities at all institutional tiers, embracing inclusivity, formulating robust financial strategies, fostering economic diversification, enhanced monitoring, sustainable coastal protection, forward-thinking governance, and prudent natural resource management.

A ROADMAP FOR THE MALDIVES

1 Towards improved evidence

Strengthen surveillance mechanisms to assess the health and vitality of marine ecosystems.

Implement a nationwide system using ground-level monitoring and satellite and aerial sensors to map and monitor coral reefs, mangroves, and seagrasses. No baseline information nor trends are currently available for any indicator of reef health in the Maldives (as of Feb 2023). Despite data collection efforts that started in 1998, the Government does not yet provide official statistics on extent, location, baselines or trends of cover, diversity and abundance for coral, fish, and macroinvertebrates, nor water quality.

Expand Long-term Plots

- Increase the coverage of long-term plots to capture reef variability, measuring indicators like coral cover, coral diversity, and health.
- Measure sedimentation rates on islands and monitor carbonate production in corals and calcifying algae.

Fishery Dynamic

- Enhance understanding of reef and live-bait fisheries by mapping fishing grounds, quantifying stocks, and collecting data on fish consumption
- Implement thorough sampling and establish clear protocols to harmonize diverse data collection methods, and ensure that the information collected can be integrated into a national system

Climate and Hydrological Monitoring

Expand the network of tide gauges, currently standing at three, for continuous sea-level monitoring. Given the vast spread of atolls in the Maldives, such an expansion is vital for accurately capturing localized sea-level variations.

Tailored Early Warning Systems

- Develop and implement a dedicated system for real-time monitoring and forecasting of coral bleaching, specifically calibrated to the unique environmental conditions of the Maldives
- Deploy buoy systems with underwater temperature sensors at varying depths to assist in the early detection of anomalies like marine heatwaves which can lead to coral bleaching

Continuous Monitoring

- Implement a robust monitoring system to track changes in coastal dynamics, sea levels, and the health of natural barriers.

Pollution and Human Impact Monitoring

Develop a comprehensive National Environmental Data Collection System focusing on quality and compliance monitoring. This system should be designed to track the impact of ocean pollution, coastal fishing, groundwater depletion, and climate change on ecosystems and communities. It should also monitor indicators of coastal vulnerabilities. Waste Management: Set up a National Data and Information Registry dedicated to waste monitoring. Insufficient data collection and reporting hinders the stocktaking of wastewater management in the industrial, agricultural, and service sectors in the Maldives. Protected Areas: Improve data collection on ecosystem health and visitor numbers and their impacts, particularly in high-visitation PAs.

Local Capacity Building

Emphasize capacity building at the island level, ensuring that communities are equipped to contribute to and benefit from the monitoring systems. Use tools like the World Bank's Kobo Tool Box to build capacity for ground-level monitoring.

2 Towards improved national planning

It is important for the Maldives to establish a Marine Spatial Planning framework. As per the commitments under the Noo Raajje initiative, the GoM should prioritize and ensure the conservation of 20% of the Maldives' marine areas and institute a Marine spatial planning (MSP) process. Accelerate the MSP process in the Maldives, recognizing its importance in balancing conservation and development goals. MSP is a public method used to coordinate human activities in marine and coastal regions, ensuring ecosystem health and sustained benefits for human well-being. MSP, being a public participatory process, should leverage the best available data on both the marine environment and human activities. The MSP should encompass a wide range of human activities, including but not limited to fishing, shipping, renewable energy, aquaculture, and infrastructure development. It must be integrated with the Strategic Environmental Assessment (SEA) and other sectoral plans, like the Fifth Tourism Master Plan. MSP considers the cumulative nature of impacts from various activities, rather than looking at each activity in isolation. Regularly updated with new data and research, MSP is crucial to prevent fragmented development and ensure a resilient blue economy.

3 Towards Enhanced Governance and Institutional Capacity

Strengthen environmental governance and risk management

Implement Comprehensive SEA Process

Integrate the Strategic Environmental Assessment (SEA) into the national planning mechanism to factor in the full range of environmental, social, and climate change impacts right from policy formulation stage allowing for preventative risk management for certain sectors.

Strengthen Environmental Due Diligence

- Improve the Maldives' environmental due diligence by widening the EIA scope to include areas outside direct project limits.
- Update the EPA's standard screening form to account for cumulative effects.
- Customize EIA Terms of References for each project to ensure comprehensive impact assessment and a stronger due diligence process.
- Integrate consistent public involvement in all EIA project phases to ensure transparency and effectiveness.
- Employ internet-based tools to streamline and enrich the public consultation process.
- Embrace mitigation hierarchy for a structured approach to environmental impacts, emphasizing avoidance, minimization, restoration, and final offsetting of any residual effects.

Comprehensive Risk Assessments

Before initiating any coastal infrastructure project, conduct thorough risk assessments that consider current vulnerabilities, future climate change scenarios, and potential socio-economic impacts.

Strengthen the capacity of key agencies, such as MMRI and EPA

- Mobilize human, technical, and financial resources to strengthen the capacity of the Environmental Protection Agency (EPA) and the Maldives Marine Research Institute (MMRI) to fulfill their mandates.
- Promote inter-agency collaborations involving government entities, international organizations, and academic institutions to foster knowledge transfer.
- Update the National Environmental Action Plan (NEAP) regularly, integrating environmental insights into national development. The most recent NEAP (2009-2013), marked the third iteration of the plan, but a decade has passed without a subsequent update. Ensure active participation from diverse stakeholders like government bodies, private entities, civil groups, development allies, and local communities. Equip Island Councils with the knowledge to factor environmental considerations into development plans. Increase citizen awareness about the full implications of coastal development projects.

4 Towards Conserving High-Biodiversity Areas

Strengthen the marine protected areas system

- Expand the coverage of Marine Protected Areas (MPAs) in the Maldives by identifying and prioritizing Key Biodiversity Areas – areas with high biodiversity and those under threat are adequately protected.
- Further, extend the recognition of Other Effective Area-based Conservation Measures (OECM) to encompass private sector initiatives and community conservation zones, encouraging local efforts towards biodiversity preservation.
- Review PA Categorization: Review the categorization of PAs based on ecosystem types to measure progress in achieving protection targets outlined in the Strategic Action Plan (SAP) and National Biodiversity Strategy and Action Plan (NBSAP).
- Prioritize the development and implementation of management plans for the 74 PAs currently lacking them. These plans should encompass the establishment of a management office, sustainable financing models, and staff training in awareness-raising, visitor monitoring, and enforcement of management rules.

Habitat Protection and Sustainable Use

- Safeguard coral reefs from pressures of coastal development and climate impacts. Identify and protect areas with high coral cover, resilience, or abundant specific species for sustainable use and future protection. Impose protective measures for mangroves, especially those affected by die-off, to preserve national diversity. Protect these areas from land reclamation, degradation, and deforestation.
- Formulate a medium-to-long term financial strategy for MPAs, detailing funding avenues like the Green Fund, use-of-proceeds bonds, and the introduction of a Conservation Trust Fund.

Improve State Capacity

- Address the limited technical expertise within the central government and local councils for Protected Area (PA) management. Given the Decentralization Act's mandate for local councils to govern natural resources, it's imperative to also build their technical capabilities. Additionally, as the Government shifts towards delegating PA management roles to local councils, ensure they are adequately equipped and trained for the responsibility.
- Empower Island and Atoll Councils in Conservation: Advocate for enhanced participation of Island and Atoll Councils in conservation initiatives by implementing supportive policies and promoting decentralized governance structures.

5 Towards Sustainable Coastal Protection Practices

National Coastal Zone Management Strategy

- Prioritize coastal protection within a national strategy and seamlessly integrate it into the updated National Spatial Plan (NSP).
- Ensure that the coastal components of the NSP are in sync with the Marine Spatial Plan.
- Adopt a seascape approach, which considers the holistic management of coastal areas, integrating socio-economic factors with environmental and cultural considerations.

Harmonize Development Plans

Align zonal, regional, and island-level strategies with the overarching NSP, considering the close relationship between marine ecosystems and the tourism and fisheries sectors.

Resilient Coastal Infrastructure

- Focus on developing infrastructure that is resilient to both current and future challenges. This includes considering the impacts of climate change and ensuring that maladaptation is avoided.

Comprehensive Risk Assessment

- Before initiating any coastal infrastructure project, conduct thorough risk assessments that consider current vulnerabilities, future climate change scenarios, and potential socio-economic impacts.
- Prioritize adaptive infrastructure designs that allow for flexibility in the face of evolving conditions or emerging data. Such designs should encompass structures capable of retrofitting, or relocation as circumstances dictate.

Nature Based Solutions (NbS)

- Explore the viability, effectiveness, and scalability of nature-based solutions for coastal protection, including supporting pilots.
- Implement ecosystem-based management approaches to conserve biodiversity and deliver ecosystem services.
- Advocate for the recognition and enhancement of Heyhli in the Maldives. This indigenous term refers to coastal vegetation, including mangroves, palms, and coastal shrubs that acts as a buffer against climate hazards.
- Emphasize the importance of maintaining healthy coral reefs for coastal protection, especially in light of their role in providing sand sediments to coasts.
- Support initiatives like the “Building Climate Resilient Safer Islands in Maldives” project under the Green Climate Fund.

Expand Mangrove and Seagrass Initiatives

While conservation efforts for mangroves are underway, there’s a need to focus on direct coastal adaptation involving both mangroves and seagrasses. Advocate seagrass restoration projects, particularly targeting species like Zostera marina, to stabilize coastlines and nurture fisheries.

Promote Littoral Vegetation

- Encourage the protection, planting, and restoration of littoral vegetation, including non-mangrove trees like palms. Highlight their role in mitigating the impacts of storms, attenuating wave energy, and enhancing sediment accretion.

Conduct Comprehensive Viability Assessments

- Before implementing any NbS, recommend thorough assessments to ascertain their feasibility in the Maldivian context, taking into account ecological, socio-economic, and cultural considerations.

Piloting NBS and scaling up

Pilot-test various NBS interventions to understand their efficacy, and costs, and prepare a roadmap for scaling up.

Adopt Hybrid Approaches

In areas where natural barriers have eroded rapidly, recommend the integration of engineered structures with NbS. For instance, support the deployment of artificial structures to reinforce coral reefs, followed by coral transplantation, ensuring both immediate and long-term coastal protection.

6 Towards improved natural resource extraction patterns

Strengthening Coral Rehabilitation and Restoration

Despite the establishment of the National Coral Reef Restoration and Rehabilitation Program in 2019, there's a need for greater clarity on its execution. Addressing the disconnect between the Maldives' coral reef monitoring system and the national restoration program is paramount.

Harmonise Restoration Efforts

- Given the varied scale and dispersion of restoration activities across the Maldives, efforts should be harmonized to facilitate upscaling and to ensure consistent assessment of effectiveness on a national level.

Strengthen Data Utilization

Enhance the program's scientific foundation by ensuring that data from long-term monitoring sites directly support and inform restoration activities.

Boost Collaboration

- Foster stronger intra-governmental, inter-agency, and inter-organizational cooperation to effectively address capacity and resource challenges.

Develop a Transparent Framework

- Create a comprehensive, structured framework that outlines the program's goals, priorities, action areas, timelines, and budgets. This framework should be made available to the public via the MMRI website to promote transparency and stakeholder engagement. Establish a robust legal, governance, and financial structure to underpin and enhance the promotion and support of restoration initiatives.

Sustainable Tourism Planning

- Prioritize sustainable tourism management, focusing especially on heavily touristic atolls.
- Ensure compliance with environmental guidelines in tourism activities and infrastructure design.
- Transition from nature-based tourism to ecotourism models that ensure minimal environmental impact.
- Execute the responsible visitor program from the Fifth Tourism Master Plan to enlighten tourists on preserving environmental sustainability.
- Re-evaluate mechanisms like the Green Tax and MPA access fees to better offset the environmental effects of tourism.

Fisheries

- Continue to strengthen sustainable coastal fisheries management, and support alternatives for live bait in tuna fishing, and explore diversification opportunities (including through domestic mariculture).
- Utilize quantitative stock assessments to determine sustainable catch levels and integrate these assessments into both fisheries management plans and MPA designations to prevent overfishing and optimize MPA management.
- Enhance monitoring, control, and surveillance efforts to prevent unauthorized fishing – both foreign and domestic.
- Undertake a comprehensive value-chain analysis in the sector to identify challenges and opportunities for innovation.

7 Towards better pollution management

Decentralized Waste Management

- Establish Island Waste Resource Management Centers (IWRMCs) on all inhabited islands and implement an effective logistics system for waste transfer.
- Implement technical training programs for local waste management operators and technicians.
- Explore Extended Producers' Responsibility (EPR) and Take-Back schemes to manage products with significant environmental footprints.
- Establish concrete obligatory reuse and recycling targets for both inhabited and resort islands.
- Continue to support the 3Rs: reduce, reuse, and recycle – including nudging household behavior.

- Increase public awareness, monitoring, and enforcement of waste practices through budget allocation and community participation.

Improved Wastewater Management

- Develop a comprehensive wastewater management plan that accounts for all aspects of the wastewater cycle, particularly addressing the challenges posed by increasing tourism arrivals.
- Consider managing wastewater during periods of fluctuating volume and seasonal changes due to tourism, ensuring efficient and sustainable wastewater management.
- Prioritize investments in wastewater collection, treatment, and disposal, with a focus on islands with smaller populations lacking these facilities.

Improved monitoring of solid and liquid waste

- Establish a comprehensive framework for monitoring solid-waste and liquid-waste, involving local specialists, citizen science, and low-cost technology.
- Periodically train the technicians at IWRMCs and Regional Waste Management Facilities (RWMFs).

Expand rainwater harvesting to enhance freshwater availability and minimize runoff

- Promote rainwater harvesting and desalination to reduce reliance on bottled water.
- Develop a water conservation rating system to encourage local-level water conservation efforts.
- Investigate infiltration-based drainage methods to restore deteriorated groundwater caused by untreated wastewater infiltration.

8 Towards Bridging the Nature and Climate Financing Gap

Develop a financing plan alongside a proper public investment management framework to close the nature and climate financing gap. Continue efforts towards fiscal consolidation, explore opportunities for establishing a conservation trust fund, implement environmental fiscal reforms, and introduce innovative financing instruments while being mindful of debt distress and potential distributional impacts. Formulate and implement a comprehensive financing plan for nature and climate actions, taking into account a proper public investment management framework and continuing efforts towards fiscal consolidation. Roughly US$ 1.6 billion has been mobilized for nature and climate efforts in the Maldives since 2015 through grants, concessional debt, non-concessional debt, and green tax revenues, yet the total financing requirements could be as high as US$ 12.5 billion through to 2030. Hence, the Maldives urgently needs to establish a comprehensive financing plan to implement its climate adaptation strategy. However, such a plan should be devised considering the ongoing fiscal vulnerabilities that the Maldives faces, and carried out in parallel with sound public investment management and continued measures for expenditure reforms and revenue mobilization.

Establish a dedicated trust fund to mobilize resources for conservation and climate adaptation. A conservation and climate adaptation trust fund with both a sinking fund and an endowment fund window may attract a wide range of donors and investors, contributing to the sustainable financing of both short-term and long-term conservation and climate resilience priority activities from concessional, philanthropic, and private sector resources.

Explore opportunities for environmental fiscal policy reforms

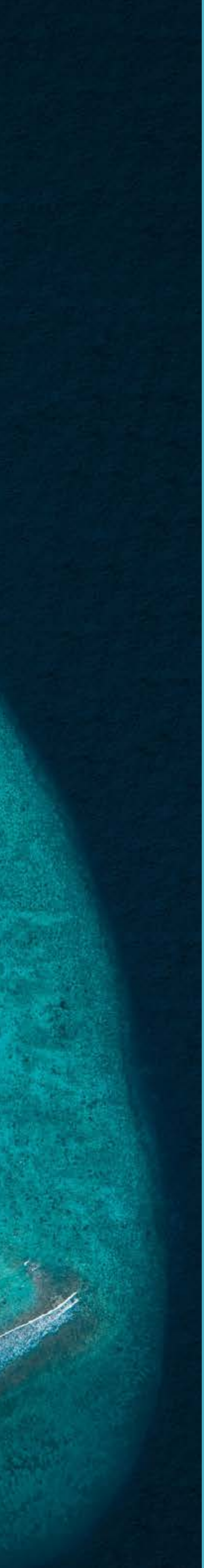
Environmental fiscal policy reforms may reduce market distortions, internalize externalities, increase revenues and eliminate inefficient expenditures, and ultimately lead to positive behavioral changes that bring about positive impacts to the environment. Such reforms may include the removal of fossil fuel subsidies in fishing vessels, removing fish floor prices, increasing the Green Tax to better reflect environmental damages from tourism, directing a higher share of the Green Fund to conservation efforts, and introducing and reforming user fees (e.g., waste collection and disposal). However, the potential impacts to different social groups should be considered, and in relevant cases, conditional cash transfers to vulnerable and low-income households should be implemented in parallel to mitigate adverse impacts from fiscal reforms.

Evaluate the desirability of innovative financing instruments

The Maldives should conduct an in-depth evaluation of the potential benefits, costs, and risks of innovative financing instruments such as debt-for-nature swaps and use-of-proceeds bonds (such as blue bonds). In addition to traditional bonds, the Maldives should explore sustainability-linked bonds due to their flexibility in fund allocation, increased transparency, and potential to lower borrowing costs. Wildlife Conservation Bonds (WCB) may also help preserve specific species. A comprehensive blue carbon strategy with a rigorous MRV system may also garner investor interest and attract international funding. Notwithstanding, any plans for new domestic and external debt should be approached with prudence, given the high risk of debt distress.

In conjunction with the aforementioned recommendations, the importance of behavioral changes cannot be overstated. Individual lifestyle choices and community actions not only complement but also amplify the impact of all other suggestions presented in the CEA. To nurture pro-environmental behaviors, invest in targeted awareness campaigns, integrate environmental education into school curriculums, and nudge through incentives such as tax breaks or recognition for sustainable practices.

To ensure a sustainable blue natural capital in the Maldives, addressing implementation gaps and enhancing existing practices is as crucial as implementing new recommendations from the CEA. The National Strategic Action Plan (NSAP) 2019-2023, established by the GOM, positions "blue economy" as Maldives' foundational priority. This is reflected in numerous existing laws, regulations, policies, and initiatives that are already in place. However, there is a critical need for their enhanced implementation. For instance, important institutional mechanisms like EIAs, that ensure responsible coastal development, occasionally face instances where their processes are overshadowed in the guise of 'national interest'. While regulations exist to protect coral species, their implementation remains a challenge. Also, several MPAs have been reduced to 'paper parks' — designated areas with no effective enforcement, resulting in ecosystem degradation. Infrastructure and capacity building are required to enforce these laws effectively, coupled with public education initiatives. In charting the path forward for the blue economy, the Maldives needs a two-pronged approach of refining current practices and pioneering new, sustainable ones. As the Maldives progresses, the focus should shift from merely "doing things" to "doing things better", culminating in "doing better things", as recommended in the CEA.



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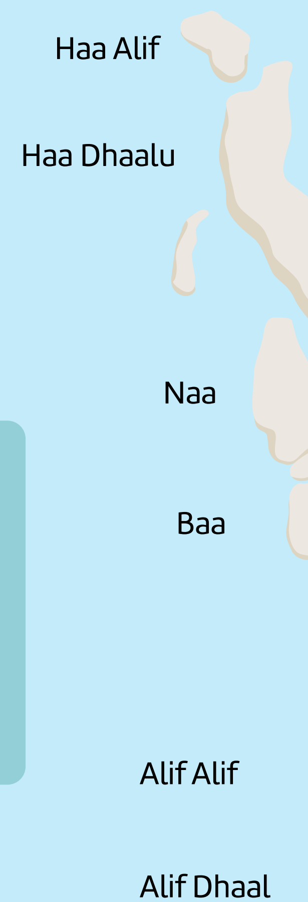
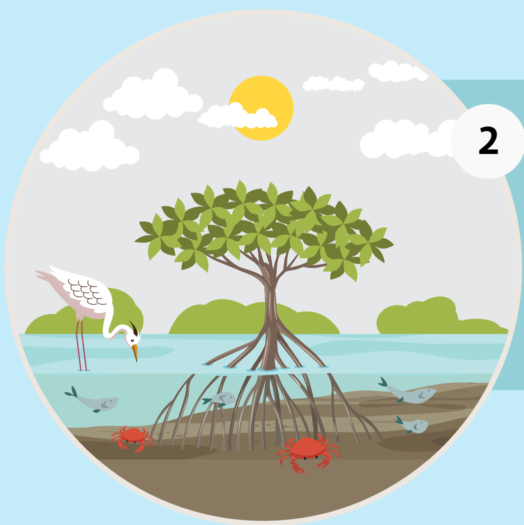
Ecosystem Services from Blue Natural Capital in the Maldives



1 Coral Reefs

Vital for fisheries, tourism, coastal safety, and as natural thermometers for the ocean

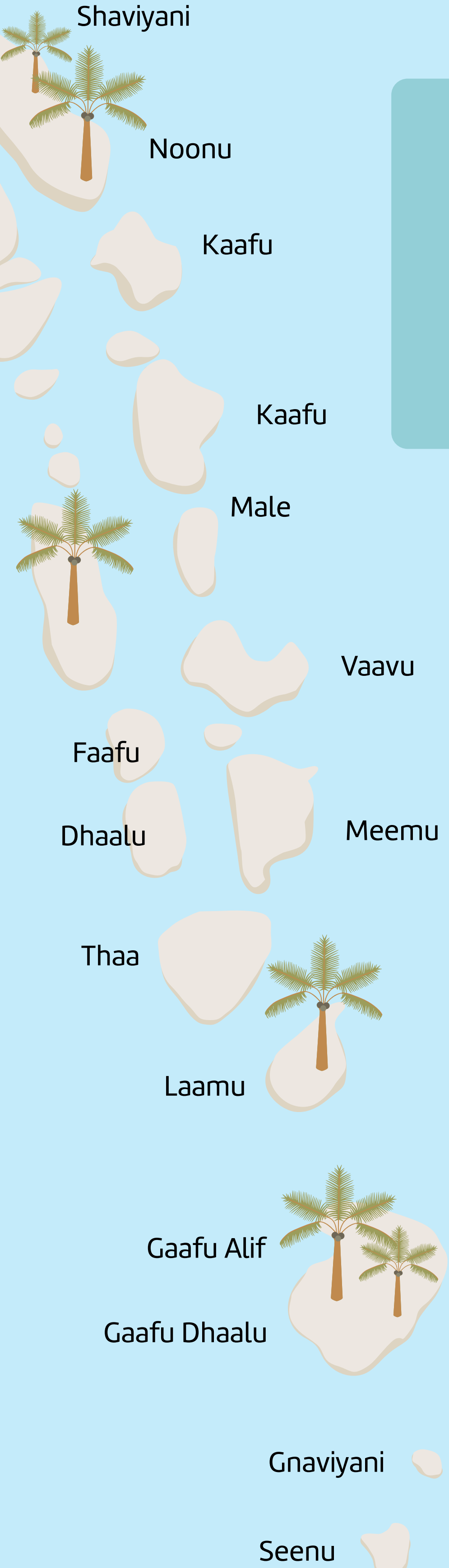


2 Mangroves

Critical for carbon storage, marine nurseries, water treatment, and as barriers against rising seas

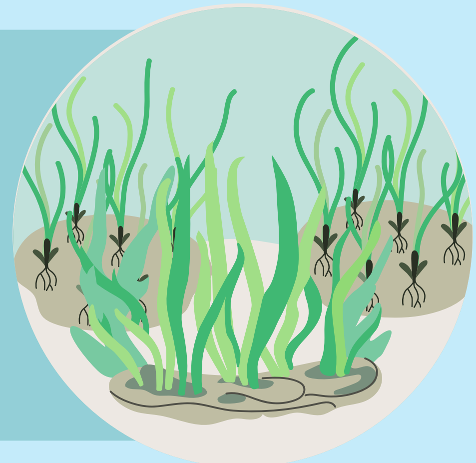
3 Beaches and Sandbanks

Recreational havens, crucial nesting sites, and frontline defenses against the impacts of rising seas



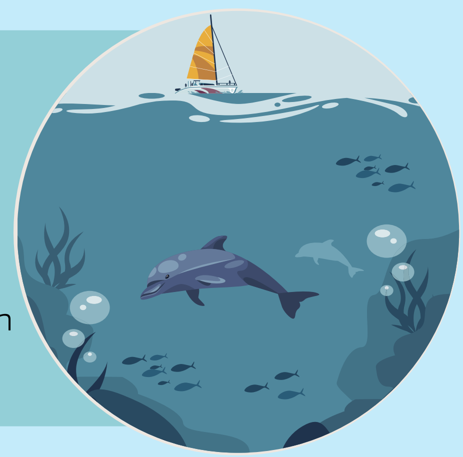
4 Seagrass Beds

Oases of the sea, providing habitats, aiding in water clarity, carbon storage, and combating climate change



5 Open Ocean and Blue Waters

The heart of marine biodiversity, supporting fisheries, and playing a part in global climate regulation



6 Lagoons and Atolls

Peaceful sanctuaries that boost tourism, provide habitats, and reduce the impacts of winds and storms.”

Contents

List of Tables

List of Figures

List of Boxes

Glossary

Atoll
A ring-shaped coral reef, island, or series of islets. An atoll surrounds a lagoon, either partially or completely. The Maldives is made up of 26 such atolls

Beach Nourishment
The process of adding material (usually sand) to a beach to increase its size and combat erosion

Benthic Macroalgae
Algae that grows in the benthic (bottom) zone of the ocean. They can be seen with the naked eye and provide important services in marine ecosystems

Bioremediation
The use of living organisms, like microbes and bacteria, to remove contaminants, pollutants, and toxins from soil and water.

Blue Bonds
Debt instruments issued by governments, development banks, or others to finance marine and ocean-based projects that have positive environmental, economic, and climate benefits.

Blue carbon offset program
An initiative that leverages the capacity of marine and coastal ecosystems to sequester and store carbon as a way to offset greenhouse gas emissions.

Blue Economy
The sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of the ocean ecosystem. It's particularly pertinent to SIDS as their economies heavily depend on marine resources.

Blue Natural Capital
Natural resources from marine and coastal environments that provide material or non-material benefits.

BPEO (Best Practicable Environmental Option)
The option that provides the most benefit or least damage to the environment, at acceptable cost, in the long term as well as in the short term.

Calcifying Organisms
Organisms that build their shells or exoskeletons from calcium carbonate, including corals, coccolithophores, foraminifera, echinoderms, crustaceans, and mollusks.

Carbon Sequestration (Blue Carbon)
The process by which marine plants (like mangroves, seagrass, and algae) absorb or "sequester" carbon dioxide from the atmosphere, helping to mitigate climate change.

Carbonate Accretion
The process of growth or increase in size by gradual external addition or accumulation of calcium carbonate material in coral reefs.

Changing Wealth of Nations (CWON)
A database maintained by the World Bank that measures countries' comprehensive wealth across produced capital, human capital, and natural capital.

Climate Resilience
The ability of a system, community or society exposed to climate change to resist, absorb, accommodate, recover from, and transform in a timely and efficient manner.

Climate Vulnerability
The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change. The Maldives is considered highly vulnerable due to its low-lying atolls.

Concessional Financing
Loans that are offered with more generous terms than market loans, including lower interest rates, longer repayment periods, or lower fees. They are often provided by development banks or agencies to support development projects.

Coral Bleaching
A phenomenon in which corals lose their vibrant colors and turn white due to environmental stress, most commonly from elevated water temperatures.

Coral Reefs
Underwater ecosystems built by colonies of tiny animals found in marine waters containing few nutrients. These biodiversity hotspots provide shelter, breeding grounds, and feeding areas for numerous marine species.

Coral Reef Watch Satellite Monitoring and Modeled Outlooks
A program by the National Oceanic and Atmospheric Administration (NOAA) that uses remote sensing to monitor, predict, and report on changes in the coral reef environment worldwide.

Coastal Erosion	The process of wearing away and removal of material along the coastline due to natural forces like wave action, currents, or wind.
Debt distress	A situation where a country is unable to service its external debt. This can result from various factors, such as a decrease in exports or an increase in fiscal deficit.
Debt-for-Nature Swaps	A financial transaction where a portion of a developing nation's foreign debt is forgiven in exchange for local investments in environmental conservation measures.
Decentralization Act	Legislation that was passed in April 2010, which makes Island Councils accountable to Atoll Councils and Atoll Councils accountable to the Local Government Authority (LGA).
Ecosystem Services	Benefits that humans receive from nature, which includes provisioning services (like food and water), regulating services (such as climate regulation), supporting services (like nutrient cycling), and cultural services (like recreational benefits).
El Niño	Periodic warming in sea surface temperatures across the central and east-central Equatorial Pacific that affects global weather patterns.
ENSO (El Niño-Southern Oscillation)	A recurring climatic pattern involving changes in the teperature of waters in the central and eastern tropical Pacific Ocean.
Environmental Decision Statement (EDS)	Permission to proceed with a project, issued after an Environmental Impact Assessment (EIA).
Epifauna	Aquatic animals that live on the surface of underwater substrates.
Exclusive Economic Zone (EEZ)	A sea zone over which a state has special rights to explore and exploit marine resources.
Extended Producer Responsibility (EPR)	An environmental policy approach where producers take responsibility for the management of their products when they become waste. EPR policies encourage manufacturers to design environmentally-friendly products by holding producers responsible for the costs of managing their products at end of life.
Fiscal consolidation	A policy aiming to reduce deficits and the accumulation of debt in the public sector.
Grant Financing	Non-repayable funds or products disbursed by one party (grant-makers), often a government department, corporation, foundation or trust, to a recipient, often (but not always) a nonprofit entity, educational institution, business or an individual.
Green Bonds	A type of fixed-income instrument that is specifically earmarked to raise money for climate and environmental projects
Green Measures (Nature-Based Solutions)	These refer to the use of natural systems or the enhancement of natural processes to achieve specific outcomes, such as erosion prevention, flood reduction, or habitat improvement. This could include measures like the planting of mangroves or other vegetation to stabilize shorelines (also known as "Living Shorelines"), the restoration of wetlands to provide natural flood buffers, or the creation of oyster reefs to reduce wave energy and prevent erosion.
Greenium	The pricing advantage that green bonds or other sustainable financial products have over comparable conventional bonds.
Grey Measures (Hard Infrastructure	These are traditional engineering solutions, often involving concrete or steel structures built to resist natural forces. In a coastal setting, this might include sea walls, groynes, and revetments to prevent erosion or storm surge barriers to reduce flooding. While these solutions can be very effective in the short term, they can also be costly to install and maintain and may have negative impacts on the environment.
Gross Domestic Product (GDP)	The total value of goods produced and services provided in a country during one year.
Human Capital	The skills, knowledge, and experience possessed by an individual or population, viewed in terms of their value or cost to an organization or country.

Key Performance Indicators (KPIs)	Measurable values that demonstrate how effectively a company or a country is achieving key objectives or targets.
Lagoon	A shallow body of water separated from a larger body of water (such as a sea or ocean) by a barrier such as a sandbar, coral reef, or barrier island.
Littoral Revegetation (Palms, Shrubs)	Planting native vegetation in the littoral (shoreline) zone to stabilize the soil, prevent erosion, and enhance habitat.
Maladaptive Pathway	A sequence of decision-making and subsequent actions that initially appear to address adaptation needs, but ultimately exacerbate vulnerability to climate change in the long term.
Marine Protected Area (MPA)	An area of the ocean where human activities are more tightly regulated than the surrounding waters – similar to parks we have on land. These places are given special protections for natural or historic marine resources by local, state, territorial, native, regional, or national authorities.
Mitigation Hierarchy	A decision-making framework used in impact assessments that prioritizes avoiding impacts wherever possible, then minimizing those that cannot be avoided, then restoring damaged ecosystems, and, as a last resort, offsetting any unavoidable impacts.
Monospecific Stands	Areas of forest or habitat that consist of only one species.
Nature-Based Solutions (NBS)	Actions to protect, sustainably manage, and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.
Natural Capital	A nation's stocks of natural assets which include geology, soil, air, water and all living things. Some of these natural assets provide people with free goods and services, often called ecosystem services, which include clean water, fresh air, a stable climate, food, and recreation.
Nationally Determined Contribution (NDC)	A country's planned efforts under the Paris Agreement to reduce national emissions and adapt to the impacts of climate change.
Non-Concessional Loans	Loans provided on terms that are similar to those of commercial banks, including market-level interest rates and shorter repayment periods.
Net-Zero Emissions	Achieving a balance between the greenhouse gases put into the atmosphere and those taken out.
Nutrient levels	The concentration of essential elements, such as nitrogen and phosphorus, in an environment, which can have significant impacts on the growth and health of organisms
Paris Agreement	An international treaty negotiated by the United Nations Framework Convention on Climate Change (UNFCCC) that aims to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels.
Produced Capital	All man-made, physical assets, including buildings, machinery, equipment, and infrastructure. It can also be seen as the stock of 'created' wealth that aids in production.
Public Goods	Goods that are non-rivalrous (one person's use doesn't decrease availability for others) and non-excludable (no one can be prevented from using it). Examples include clean air and public parks.
Reef Flats	The shallow part of a coral reef platform adjacent to the island surface, often serving as natural breakwaters that reduce the amount of wave energy reaching the shorelines.
RCP2.6 and RCP4.5	Representative Concentration Pathways that are used for making projections about future climate change. RCP2.6 assumes that global annual greenhouse gas emissions peak between 2010-2020, with emissions declining substantially thereafter. RCP4.5 is a stabilization scenario where total anthropogenic radiative forcing is stabilized shortly after 2100.
Seagrass Meadows	Underwater flowering plants found in shallow marine waters. They play a crucial role in carbon sequestration and serve as habitats for many marine species.

Sea-Level Rise	An increase in the level of the world's oceans due to climate change.
Small Island Developing States (SIDS)	A group of small island countries that tend to share similar sustainable development challenges, including small population, limited resources, remoteness, susceptibility to natural disasters, and excessive dependence on international trade.
Soft engineering solutions	Environmentally friendly methods for managing coastal erosion and other environmental issues. These methods often work with nature rather than against it and can include beach replenishment, restoration of coastal vegetation, and the establishment of tidal wetlands.
Stony Coral Tissue Loss Disease (SCTLD)	A lethal disease affecting coral reefs, characterized by the rapid loss of live coral tissue.
Strategic Environmental Assessments (SEA)	A systematic decision support process, aiming to ensure that environmental and possibly other sustainability aspects are considered effectively in policy, plan and program making.
Sukuk	An Islamic financial certificate, similar to a bond in Western finance, that complies with Sharia law.
Sustainable Bonds	Also known as use-of-proceeds (UoP) bonds, these are bonds where the proceeds are specifically used towards achieving green or social outcomes.
Sustainability-Linked Bonds (SLBs)	A type of bond where the financial or structural characteristics of the bond can change depending on whether the issuer meets predefined sustainability/ESG objectives.

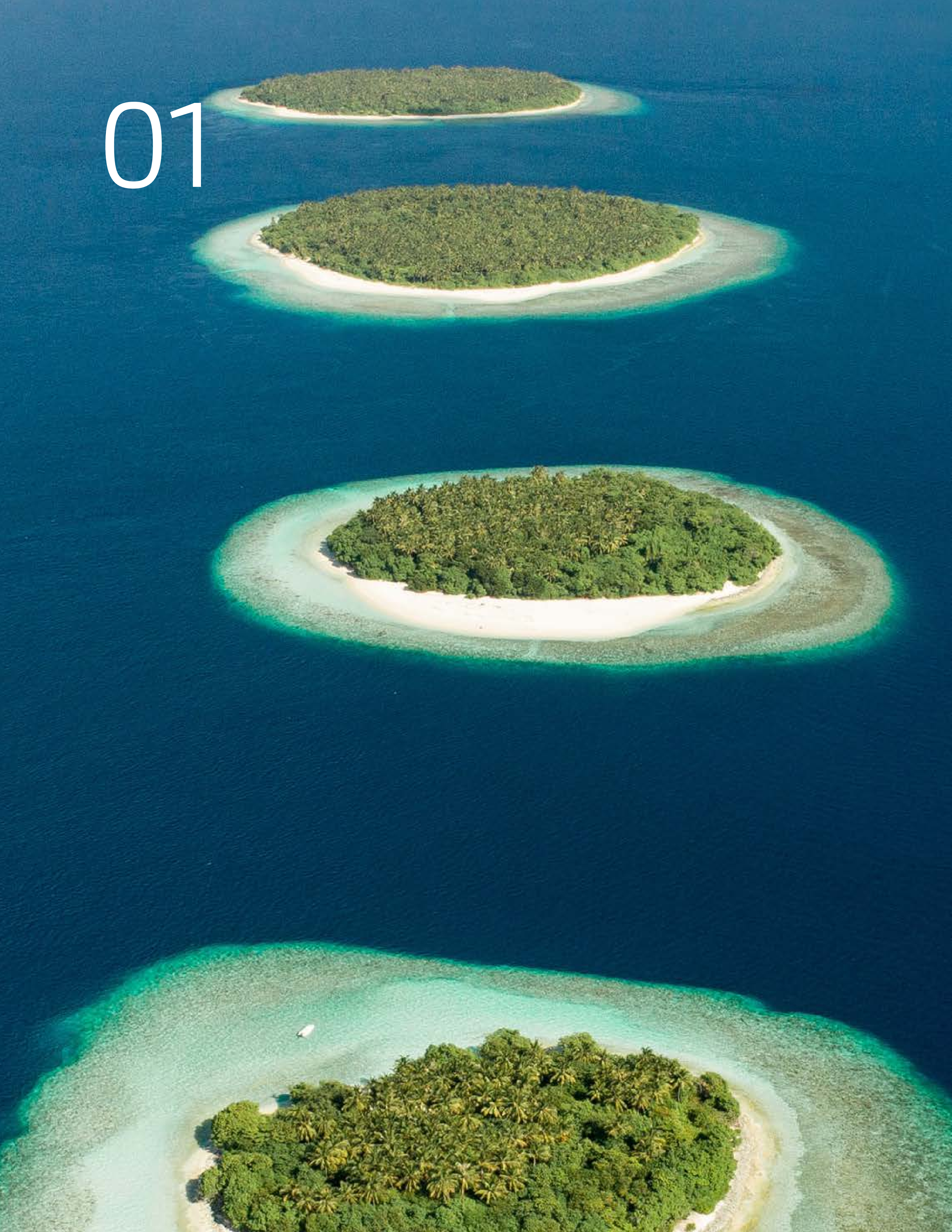
Abbrieviations

ADB	Asian Development Bank
BPEO	Best Practicable Environmental Option
BCC	Biodegradable Carbon Content
BCS	Blue Carbon Strategy
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COTS	Crown-of-thorns starfish
CRW	Coral Reef Watch
CCAs	Community Conserved Areas
CCDR	Country Climate and Development Report
CFC	Chlorofluorocarbons
COP	Conference of the Parties
CWON	Changing Wealth of Nations
DCR	Decentralized Composting and Recycling
DFC	Development Finance Corporation
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPPA	Environmental Protection and Preservation Act
EDS	Environmental Decision Statement
EMP	Environmental Management Plan
ENSO	El Niño Southern Oscillation
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EWS	Early Warning System
EFP	Environmental Fiscal Policy
ESMPs	Environmental and Social Management Plans
FRA	Forest Resource Assessment
FPA	Fisheries Partnership Agreement
GCRMN	Global Coral Reef Monitoring Network
GDP	Gross Domestic Product

GHG	GHG: Greenhouse Gas
GPP	GPP: Gross Primary Productivity
GoM	GoM: Government of Maldives
GVA	GVA: Gross Value Added
GDP	GDP: Gross Domestic Product
GEF	GEF: Global Environment Facility
GST	GST: Goods and Services Tax
GMW	GMW: Global Mangrove Watch
IEE	IEE: Initial Environmental Examination
IMF	IMF: International Monetary Fund
IMO	IMO: International Maritime Organization
IOTC	IOTC: Indian Ocean Tuna Commission
IPCC	IPCC: Intergovernmental Panel on Climate Change
IWMC	IWMC: Island Waste Management Centre
IWRMC	IWRMC: Island Waste & Resource Management Centre
IPCC	IPCC: Intergovernmental Panel on Climate Change
ITMOs	ITMOs: Internationally Transferred Mitigation Outcomes
IFC	IFC: International Finance Corporation
IMO	IMO: International Maritime Organization
IMF	IMF: International Monetary Fund
IWRMC	IWRMC: Island Waste & Resource Management Centres
KBA	KBA: Key Biodiversity Areas
LGA	LGA: Local Government Authority
MEMP	MEMP: Maldives Environmental Management Project
MoECCT	MoECCT: Ministry of Environment, Climate Change and Technology
MIFCO	MIFCO: The Maldives Industries Fisheries Company
MCRMN	MCRMN: Maldives Coral Reef Monitoring Network
MCEP	MCEP: Maldives Clean Environment Project
MEMP	MEMP: Maldives Environmental Management Project
MoECCT	MoECCT: Ministry of Environment, Climate Change & Technology
MWR	Marine Water Reserve
MAP	Mangrove Action Project

MFMC	Maldives Fund Management Corporation
MFMRA	Maldives Fisheries and Marine Research Authority
MMRI	Maldives Marine Research Institute
MEMP	Maldives Environmental Management Project
MoECCT	Ministry of Environment, Climate Change & Technology
MARPOL	International Convention for the Prevention of Pollution from Ships
MAP	Mangrove Action Project
MWMA	Maldives Waste Management Authority
MEMP	Maldives Environmental Management Project
MCEP	Maldives Clean Environment Project
MOFMRA	Ministry of Fisheries, Marine Resources and Agriculture
MOT	Ministry of Tourism
MMS	Maldives Meteorological Service
MRV	Monitoring, Reporting and Verification
MINAGRI	Ministry of Agriculture and Animal Resources
MSPEA	Maldives Seafood Processors and Exporters Association
MLSA	Maldives Land and Survey Authority
MWSA	Maldives Water and Sanitation Authority
NBS	Nature-Based Solutions
NBSAP	National Biodiversity Strategy and Adaptation Plan
NDCs	Nationally Determined Contributions
NEAP	National Environmental Action Plan
NOAA	National Oceanic and Atmospheric Administration
NSAP	National Strategic Action Plan
NWSSP	National Water and Sewerage Strategic Plan
NGO	Non-Governmental Organization
NSAP	National Strategic Action Plan
NWWQG	National Wastewater Quality Guidelines
OTEC	Ocean Thermal Energy Conversion
OECM	Other Effective Area-based Conservation Measures
PDSAE	Project for Developing Sustainable Agricultural Economy
PET	Polyethylene Terephthalate

RCP	Representative Concentration Pathways
RRA	Rapid Resource Assessment
RWMF	Regional Waste Management Facility
SAP	Strategic Action Plan
SEA	Strategic Environmental Assessment
SCTLD	Stony Coral Tissue Loss Disease
SLR	Sea Level Rise
SIDS	Small Island Developing States
SPI	Standardized Precipitation Index.
SAMPA	South Atoll Marine Protected Area
SLB	Sustainability– Linked Bond
SUP	Single Use Plastic
STO	State Trading Organization
TMDA	Tuna Management and Development Agreement
TGST	Tourism Goods and Services Tax
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
URA	Utility Regulatory Authority
VCM	Voluntary Carbon Market
VER	Verified Emissions Reductions
WAMCO	Waste Management Corporation
WB	World Bank
WSSP	Water and Sewerage Strategic Plan
WCB	Wildlife Conservation Bond

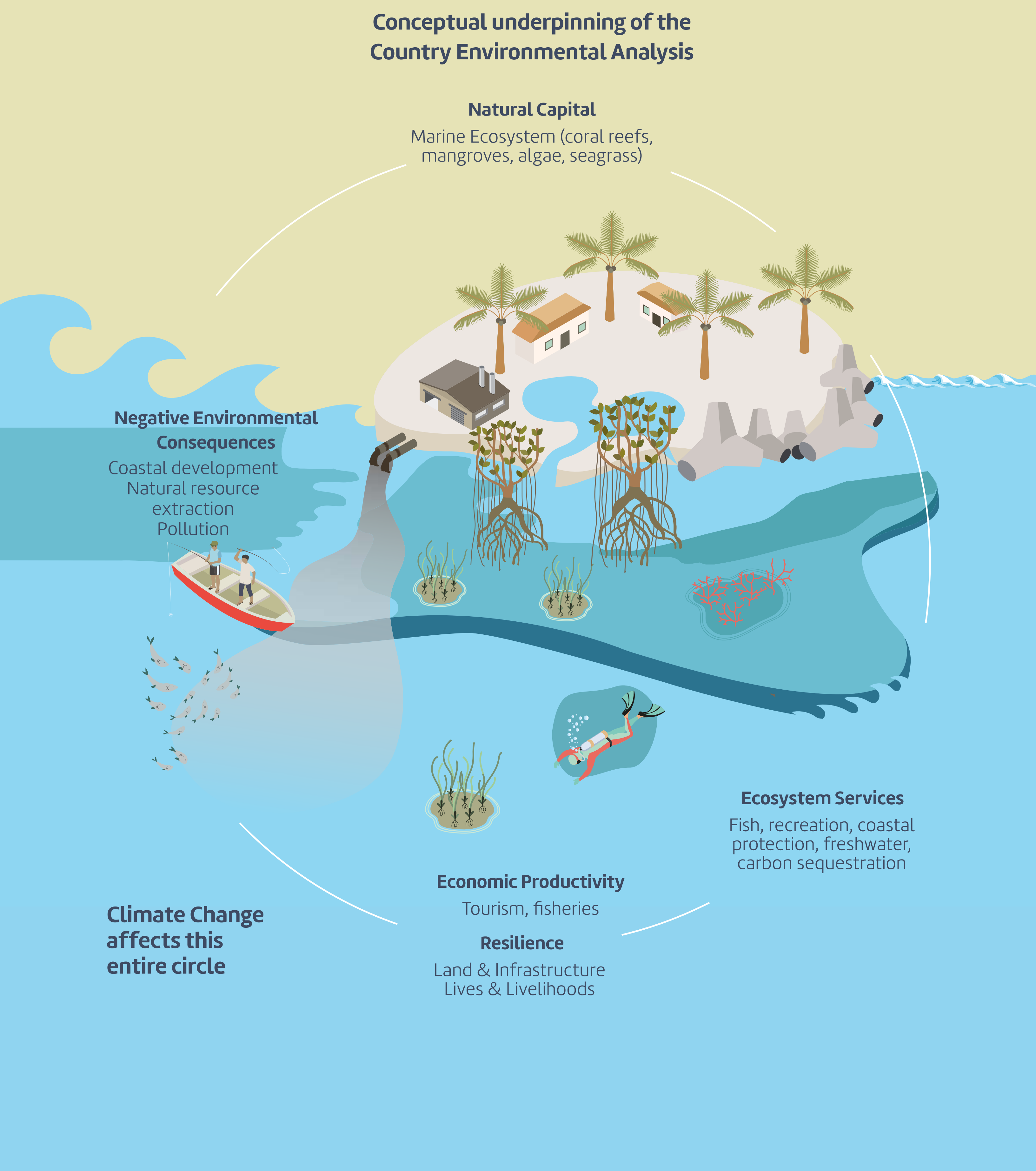

01

Introduction

1.1 Conceptual framework of the Country Environment Analysis

The Country Environmental Analysis (CEA) follows a circular conceptual framework. Figure 1 showcases the circular conceptual framework, illustrating the components and relationships within a Blue Economy, like the Maldivian one. Depending on the way natural capital and the ecosystem services it provides are being used, different economic productivity and resilience outcomes ensue, as well as potential negative environmental consequences. Figure 1 also highlights several of these environmental consequences, such as those arising from maladaptive coastal development (e.g., building harbors, dredging, and reclaiming land) and natural resource extraction (e.g., coastal fishing). These environmental consequences successively impact the country's natural capital, completing the circle. The dynamics and end results of this circular relationship can either be positive or negative. In a negative dynamic, unsustainable practices in tourism, fisheries, or land and infrastructure use result in negative environmental externalities that adversely affect natural capital. This, in turn, has consequences for economic productivity and resilience. This CEA attempts to bring this conceptual framework to the case of Maldives to better understand what the relationships have been empirically and what the role that past policies have had. Based on this analysis, this report presents recommendations for achieving a virtuous cycle, referred to as a sustainable Blue Economy.

Figure 1. Virtuous of vicious cycle?



The Maldives, an archipelago of 26 natural atolls comprised of 1,192 coral reef islands, is uniquely characterized by its Blue Natural Capital—its coastal and marine ecosystems—which represents its most significant asset.

1.2 Blue Natural Capital and the ecosystem services it provides underpins Livelihoods and Economic Growth

The Maldives, an archipelago of 26 natural atolls comprised of 1,192 coral reef islands, is uniquely characterized by its Blue Natural Capital—its coastal and marine ecosystems—which represents its most significant asset. Situated in the Indian Ocean, the archipelago supports a population of approximately 540 thousand inhabitants, one-third of whom reside in the capital city, Malé.[1] The Exclusive Economic Zone (EEZ) of the Maldives, spanning almost 1 million km^2 of the ocean, encapsulates a geographical distribution where land merely constitutes one percent, with the remaining 99 percent composed of water. Encircling each island, pristine white sand beaches and turquoise waters teem with vibrant coral gardens and a dazzling diversity of marine life. This intricate marine ecosystem and its biodiversity[2] not only distinguish the Maldives as an ecological marvel but also elevate it as one of the most coveted holiday destinations globally.

Box 1. Natural Capital and Sustainable Blue Economy definitions[3,4]

Natural Capital is defined as the "[.] stocks of natural assets and resources providing a wide range of services, often called ecosystem services, that make human life possible. The living and nonliving components of ecosystems that contribute to the generation of goods and services of value for people." Blue Natural Capital is the natural capital in coastal and marine environments, including coral reef, mangrove, and seagrass ecosystems.[5] In a sustainable Blue Economy, Blue Natural Capital is sustainably used for economic growth and improving livelihoods.

A sustainable **Blue Economy** in the Maldives can be characterized either following the weak sustainability or the strong sustainability paradigm. The key assumption under weak sustainability is that the loss of natural capital can be substituted by other forms of capital such as produced or human capital, and environmental risks and consequences are managed with a focus on the total capital stock of the economy. Strong sustainability, on the other hand, views natural capital as providing critical services, both economical and societal, that are non-substitutable. A strong sustainability framework aims to significantly curtail the loss of natural capital and puts a greater emphasis on the irreversibility of the destruction of natural capital and the moral implications for future generations.

1 World Bank. (2022). Population, total – Maldives. The World Bank Open Data. https://data.worldbank.org/indicator/SP. POP.TOTL?locations=MV

2 Maldives reef area is 4,500km2, which accounts for 3 percent of the world's total coral reef area. Reef biodiversity is considered 5th richest in the world and reef ecosystems is 7th largest in the world. There are over 250 recorded species of coral, over 1,200 species of fish, at least 20 species of marine mammals, 15 mangrove species. (MoE, 2016)

3 Guerry, A. D., Polasky, S., Lubchenco, J., Chaplin-Kramer, R., Daily, G. C., Griffin, R., .. & Vira, B. (2015). Natural capital and ecosystem services informing decisions: From promise to practice. Proceedings of the National Academy of Sciences, 112(24), 7349.

4 https://sustainabledevelopment.un.org/content/documents/6569122-Pelenc-Weak%20Sustainability%20versus%20Strong%20Sustainability.pdf

5 International Union for Conservation of Nature. (2022). Home – Blue Natural Capital. Blue Natural Capital. https://bluenaturalcapital.org/

Blue Natural Capital in the Maldives provides several economically significant ecosystem services.

Blue Natural Capital in the Maldives provides several economically significant ecosystem services. The surrounding deep oceans and coral reefs serve as valuable fish habitats, supporting both commercial and subsistence fisheries that contribute to the country's economy. The pristine clarity of the ocean water and white coral-sand beaches are a key attraction for tourists worldwide, with 1.7 million international arrivals in 2019 seeking the renowned "sun, sand, sea" experience.[6] The coral reefs and lagoons within the atolls, covering approximately half of the country's surface area (21,300 km2), offer vital habitats for various fish species. The aesthetics offered by these underwater habitats and species are of high recreational value to divers and snorkelers. In several islands, the revenue generated from reef-related tourism exceeds $908,000 per km2. Additionally, coral reefs also provide live bait to subsistence fishing activities, which contributes to over 70 percent of the national protein intake.[7]

Photo Description: Coastal Fishery, Maldives © World Bank

6 Ministry of Finance. (2021). Statistical Yearbook of Maldives.http://statisticsmaldives.gov.mv/yearbook/2021/

7 Bennett, A. , Patil, P. , Kleisner, K. , Rader, D. , Virdin, J. , & Basurto, X. (2018). Contribution of fisheries to food and nutrition security: Current knowledge, policy, and research.

By leveraging its Blue Natural Capital, Maldives has made impressive gains in developing its economy, and reducing poverty. The fisheries and tourism sectors have transformed the island nation from one of the least developed countries to a middle-income country.

By leveraging its Blue Natural Capital, Maldives has made impressive gains in developing its economy, and reducing poverty. The fisheries and tourism sectors have transformed the island nation from one of the least developed countries to a middle-income country. This has resulted in nearly doubling the real GDP per capita between 1990 and 2019 (standing at US$10,626 in 2019), making it the highest in South Asia.[8,9] Annual real GDP growth averaged 6.3 percent from 2015 to 2019, faster than other small island and upper middle-income economies. The population living below the poverty line of $3.65 per day—a threshold established for lower-middle-income countries (LMIC)—fell dramatically from 7.2 percent in 2002 to nearly non-existent levels by 2019.[10]

Natural capital is the key production factor of the Maldivian economy. The country's two main economic sectors – tourism and fisheries – depend heavily on healthy and extensive natural capital. Together, these sectors contribute over half of the country's Gross Value Added (GVA), as depicted in Figure 2. The fishing sector directly employs approximately 17,589 individuals,[11] while the tourism sector directly employs 48,664 individuals.[12] These figures approximately represent 6% and 16.2% of the total employed population, respectively, based on the 2022 Census reporting a total employed population of 300,422.[13] It is also important to note that indirect employment in these sectors is significantly higher, particularly in tourism, where some estimates suggest that up to 40 percent of the workforce is indirectly employed.[14] While the tourism sector has experienced rapid expansion and surpassed the fisheries sector in terms of relative importance since the late 1970s, the fisheries sector remains the largest primary economic activity, enjoying consistent demand from both international and local markets, including growing demand from tourist establishments such as resorts and guesthouses.[15] The large contributions of the tourism and fisheries sectors to GVA and jobs highlight their pivotal role in driving the country's overall economic development.

Beyond the direct contributions highlighted in the graph, tourism and fisheries serve as vital catalysts in the Maldivian economy, indirectly supporting associated industries like transportation, food and beverage, and local crafts.

8 World Bank 2022. GDP per capita – Maldives. https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.KD?locations=MV

9 The Maldives graduated from its Least Developed Country status in 2011.

10 World Bank. (2023). Maldives Overview: Development news, research, data. https://www.worldbank.org/en/country/maldives/overview#1

11 Maldives Bureau of Statistics. (2023). Table 9.11: Number of Fisherman by Atoll, 2014 – 2017. In Statistical Yearbook of Maldives 2023. Retrieved from https://statisticsmaldives.gov.mv/yearbook/2023/wp-content/uploads/sites/10/2023/07/9.11.pdf

12 National Bureau of Statistics – Maldives. (2020). Resort Employee Survey 2020 [PDF file]. Retrieved from https://statisticsmaldives.gov.mv/nbs/wp-content/uploads/2021/10/ResortEmployeeSurvey2020.pdf

13 Maldives Bureau of Statistics. (2022). Table EC6: Number of Employed Resident Population 15 Years of Age and Over by Employment Status, Sex and Locality, 2022 [Data set]. Retrieved from https://census.gov.mv/2022/wp-content/uploads/2023/09/EC6_090423.xlsx

14 Maldives Bureau of Statistics. (2014). Maldives: Population and Housing Census. Statistical Release: 1 Population and Households. http://statisticsmaldives.gov.mv/nbs/wp-content/uploads/2015/10/Census-Summary-Tables1. pdf

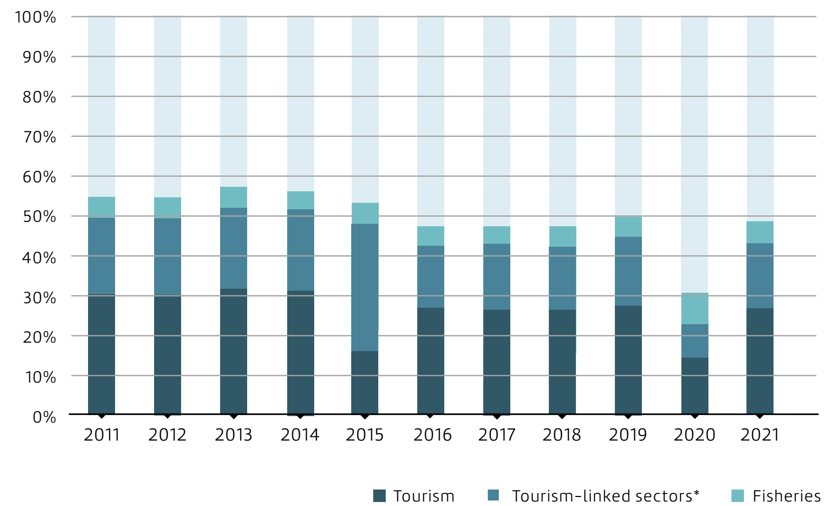
15 World Bank. (2022). Conserving Maldives' ocean resources for a sustainable livelihood. https://www.worldbank.org/en/news/feature/2020/02/27/maldives-ocean-resource-conservation-sustainable-livelihood

Blue Natural Capital, including oceanic and coastal ecosystems, is the most prevalent and important source of environmental goods and services in the Maldives.

The reinvestment of profits from these sectors further cascade into areas like infrastructure and education, driving local entrepreneurship, and enhancing the overall economic ecosystem.

Figure 2. The Maldives' economy depends heavily on the country's natural capital.

Contributions of the tourism and fisheries sectors to the Maldives' Gross Value Added



Source: World Bank, based on Maldives Bureau of Statistics.[16]* The tourism-related Value-Added contributions of other sectors are estimated based on the Tourism Satellite Account of the Maldives 2017 (TSAM).

Blue Natural Capital, including oceanic and coastal ecosystems, is the most prevalent and important source of environmental goods and services in the Maldives. The country is predominantly composed of oceanic ecosystems, accounting for 99 percent of its total area, spanning 859,000km2 17,18 In contrast, the terrestrial natural capital in the Maldives is relatively limited, with lower levels of terrestrial biodiversity. This report explores the extent to which Blue Natural Capital in the Maldives has improved or deteriorated. In particular, it reviews the available evidence regarding the precursors of natural capital valuation, which reflect changes in the condition of the country's natural resources. The findings presented in this report thus provides critical input for natural capital valuations, such as the ongoing assessment being conducted for various natural capital types in the Laamu.[19]

16 The TSAM 2017 derived the total contribution of tourism to the Maldivian economy based on 2017 Input-Output (IO) tables. The contributions are estimated for each year based on the ratio between value-added contributions in the tourism sector and tourism-related Value-Added contributions in other sectors in 2017. The tourism-related activities in these other sectors include the wholesale and retail trade of motor vehicles, fishing, the provision of financial and IT services, and construction.

17 Republic of Maldives. (2016). First Biennial Update Report to the United Nations Framework Convention on Climate Change. Ministry of Environment and Energy, Maldives. https://unfccc.int/sites/default/files/resource/Maldives%20First%20Biennial%20Update%20Report.pdf

18 Secretariat of the Convention on Biological Diversity. (2022). Main Details. https://www.cbd. int/countries/profile/?country=mv

19 MoECCT (2022). Terms of Reference - Consultancy to develop NCA. http:/ww.environment.gov.mv

The success of the Maldivian tourism sector hinges on the effective management of the country's Blue Natural Capital and the continuous provision of ecosystem services.

The success of the Maldivian tourism sector hinges on the effective management of the country's Blue Natural Capital and the continuous provision of ecosystem services. The status of marine ecosystems directly influences the revenue potential of the tourism sector, as it impacts the recreational experiences offered to visitors. A visitor survey performed by the Maldives' Ministry of Tourism in 2022 shows that most tourists visit the Maldives because of the presence of beaches (75 percent of the 1,789 respondents), underwater beauty (60 percent), and snorkeling opportunities (24 percent). A visitor survey conducted in 2014 produced similar findings, suggesting that these touristic preferences are relatively stable over time. These findings concurrently suggest that adverse changes in these conditions would reduce visitation rates.[20] Other conditions that affect recreational experiences include ocean water clarity, the absence of plastic debris on the beaches, and the diversity of marine life.

...most tourists visit the Maldives because of the presence of beaches (75 percent of the 1,789 respondents), underwater beauty (60 percent), and snorkeling opportunities (24 percent).

The Maldivian fisheries sector is closely tied to the condition of the country's Blue Natural Capital. The profitability of the fisheries industry relies on the abundance of pelagic fish species, particularly skipjack and yellowfin tuna in its exclusive economic zone, as well as reef and bait fish.[21] The replenishment of the ocean fish stocks hinges on two key factors: the volume of fish harvested and the presence of sufficient spawning biomass. In the Maldives' Exclusive Economic Zone (EEZ), the catches of skipjack and yellowfin tuna consistently remain within the maximum sustainable yield limits. These limits are set and periodically revised by the Indian Ocean Tuna Commission (IOTC). Ensuring that historical fish catches are sustainable and the ocean waters remain unpolluted is crucial. Additionally, the vitality of reef and bait fisheries is inextricably linked to the health of coral reefs. Therefore, the condition of the Maldives' blue natural capital is vital for its economy. The status of these marine resources directly influences the potential income from the country's key economic sectors.

Recognizing the significance of Blue Natural Capital as a principal driver of economic development, the GoM aspires to sustainably manage it. The Maldives' Blue Economy Strategy National Strategic Action Plan (2019-2023) emphasizes balancing economic growth with the nurturing, protection, and enhancement of its Blue Natural Capital. Central to this strategy is the preservation of vibrant seas, reefs, and lagoons.[22] The GoM has delineated specific goals within its Strategic Action Plan, including the initiation of a reef restoration and protection program and introducing regulations to curb overfishing. In line with the Maldives' commitments to the CBD (UN Convention on Biological Diversity), the government has delineated specific goals within its NBSAP (National Biodiversity Strategy & Action Plan). This includes the initiation of a reef restoration and protection program and introducing regulations to further control and management overfishing activities. The NBSAP also strives

20 Bockstael, N.E., Hanemann, W.M., Strand, I.E., 1989. Measuring the Benefits of Water Quality Improvements Using Recreation Demand Models. United States Environmental Protection Agency, Washington. EPA-230-10-89-069

21 FAO. (2019). Fisheries & Aquaculture Country Profiles: Maldives. https://www.fao.org/fishery/en/facp/mdv?lang=en

22 Government of Maldives. (2019). Strategic Action Plan. (2019-2023). (2019). https://erc. undp.org/evaluation/managementresponses/keyaction/documents/download/3556

The GoM has a target of protecting 20 percent of ocean resources by 2030, covering coral reefs, mangroves, and other important areas.

to diminish both climate-induced and human-caused pressures on coral reefs by 2025. Further, the government's ambition extends to safeguarding 10 percent of the coral reefs and 20 percent of mangroves and coastal wetlands, while actively combating ecosystem degradation. As part of the Noo Raajje initiative, the GoM aims to earmark and protect 20 percent of Maldives' marine areas, utilizing scientifically informed marine spatial plans that resonate with stakeholders.[23] On the economic side, the GoM aspires to foster growth and diversify sectors that rely on Blue Natural Capital.

Developing a resilient Blue Economy is of utmost importance to the Government of Maldives (GoM) as outlined in its Strategic Action Plan (SAP) for 2019-2023. The SAP prioritizes the Blue Economy as the main thematic area of growth for the nation, recognizing the interdependence between the economic and social well-being of the Maldives and the health of its natural environment, especially the ocean. The tourism and fisheries sectors are highly dependent on the wellbeing of the ocean, coral reefs, beaches and marine life. The GoM has a target of protecting 20 percent of ocean resources by 2030, covering coral reefs, mangroves, and other important areas. Several ministries in GoM are committed to implementing the SAP towards a resilient and sustainable Blue Economy. The Ministry of Fisheries, Marine Resources and Agriculture (MOFMRA) focuses particularly on sustainable fisheries and marine natural resources.[24] The Ministry of Climate Change, Environment and Energy (MoCCEE) focuses on the provision of a clean and healthy environment free from pollution, and the protection of the islands from coastal erosion and climate change. Furthermore, MoCCEE also mobilizes finance to adapt and mitigate the negative impacts of climate change, protection and preservation of the natural environment, and others.[25] The Ministry of Tourism (MOT) focuses on optimizing and balancing the economic, environmental, and socio-cultural benefits of tourism.[26]

The Maldives envisions future economic growth primarily through the further development of its tourism and fisheries sectors.

The Maldives envisions future economic growth primarily through the further development of its tourism and fisheries sectors. The country's Blue Economy Strategy outlines specific goals for these sectors. The GoM has aimed to achieve a 20 percent increase in the number of visitors in 2023 compared to 2018. Measures to accomplish this included adding 35,000 new tourist beds in 2023, improving marketing and communication efforts, and diversifying the range of tourism services, including the promotion of eco-tourism. Additionally, the Maldives plans to enhance the productivity and sustainability of the fisheries sector by implementing fisheries management plans, improving data collection on ecological and socio-economic aspects, and ensuring regulatory compliance. Furthermore, the country seeks to expand value-added fishery product sub-sectors like canned tuna. In summary, the strategic goals of the

23 Noo Raajje is a partnership between the Government of Maldives and the Blue Prosperity Coalition.

24 MoFMRA. (n.d.). About Us. https://www.gov.mv/en/organisations/ministry-of-fisheries-marine-resources-and-agriculture/about

25 MoECCT (2023). About Ministry of Environment, Climate Change, and Technology. https://www.environment.gov.mv/v2/en/

26 Ministry of Tourism. (2023). About Tourism Ministry. https://www.tourism.gov.mv/en/page/about_tourism_ministry

The strategic goals of the Maldivian government underscore the significance of the Blue Economy as a means for ongoing economic development and livelihood improvement.

Maldivian government underscore the significance of the Blue Economy as a means for ongoing economic development and livelihood improvement.

Photo Description: A gray heron on the beach in the Maldives Islands © Muhammadh Saamy/Unsplash

Natural capital in the Maldives has significant societal value, and the irreversible degradation of the environment has implications beyond the effect on economic productivity.

Natural capital in the Maldives has significant societal value, and the irreversible degradation of the environment has implications beyond the effect on economic productivity. To establish a sustainable Blue Economy in the Maldives, a strong emphasis on sustainability and the potential irreversible loss of natural capital for future generations is essential. Economic value measures that are frequently omitted from natural capital valuations are the non-use values of the environment or the value to society of the environment beyond the direct use of it. Examples of non-use values include bequest value, which measures the value that society places on maintaining the environment for future generations, and existence value, which measures the value to society of the existence of the natural environment and natural wonders. Non-use values are a significant component of the overall economic value of the environment but are often omitted from natural capital valuations primarily due to the difficulty in measuring these values empirically. A sustainable Blue Economy in the Maldives from a sustainability perspective should place significant emphasis on non-use values of the environment and societal implications of the potential irreversible loss of natural capital in the Maldives.

1.3 Blue Natural Capital for Climate Resilience

Maldives is considered one of the most climate-vulnerable countries in the world. On the climate risk index score, Maldives ranks 174 out of 180 countries.[27] Given its low elevation, sea-level rise threatens both the capital Malé and outlying islands, and is already contaminating water resources, reducing land area, and compromising marine-based livelihoods and ecosystems. Other existential climate threats include warmer sea-surface temperatures (SST) and their impact on coral health and fisheries, rainfall variability, more frequent and intense storms, and increases in temperature that can lead to disease outbreaks.[28]

27 Climate Watch Data. (n.d.) Maldives Climate Change Data | Emissions and Policies. https://www.climatewatchdata.org/countries/MDV.

28 United Nations Plan of Action on Disaster Risk Reduction for Resilience. (2013). Towards a Risk-informed and Integrated Approach to Sustainable Development. https://www.preventionweb. net/files/2190_VL323129. pdf

Climate change pressures are becoming more urgent, posing existential threats to the country.

Climate change pressures are becoming more urgent, posing existential threats to the country. Even if the world moves towards fulfilling the commitments articulated in the 2015 Paris Agreement and achieves net-zero targets by the year 2050, average temperatures will rise at a minimum by 1.5 to 2 degrees Celsius compared to pre-industrial levels. It is imperative, especially for vulnerable countries such as the Maldives, to deliberate on adaptation strategies against increasing climate and environmental threats. Even the best-case global mitigation scenario requires significant local action on adaptation. For the Maldives, climate change induced threats predominantly have to do with coastal erosion, sea-level rise, and coral reef degradation. Most of the physical infrastructure that supports both fisheries and a vast portion of the tourism industry are within 100 meters of the coastline, making assets particularly sensitive to these and other climate change impacts. If poorly managed, climate change impacts will make many of the low-lying atoll islands in the Maldives uninhabitable by the end of the 21st century.[29] It is, therefore, essential to identify adaptation pathways that consider the country's climate vulnerabilities, as is currently being done as part of the Maldives' Country Climate and Development Report (CCDR).

Coastal erosion and coral reef destruction are particularly clear examples of how sustainable natural capital use and climate resilience interact within the Maldivian context.

Coastal erosion and coral reef destruction are particularly clear examples of how sustainable natural capital use and climate resilience interact within the Maldivian context. Both forms of natural capital deterioration are being exacerbated by unsustainable natural capital use on the one hand (e.g., side-effects of certain coastal development infrastructure) and by climate change-related phenomena, such as sea-level rise and ocean temperature warming, on the other. Fisheries are another sectoral example of how climate-resilient and sustainable natural resource use needs to go hand in hand. Sustainable fish harvesting – coastal or offshore – depends heavily on the sustainability of fishing efforts and the fish stock. At the same time, due to lack of data and analyses, it is not clear if the sector is already or likely be heavily impacted by climate change. While impacts from with rising ocean temperatures significantly affect the migration of fish stocks, fish population health and spawning patterns, and changing habitats are probably occurring already (even if not explicitly noticed), given the importance of the sector for employment and well-being from the sector, it is important to immediately start systemic studies to understand the scale and range of impacts induced by climate change.

Natural capital is not only a source of economic development, but also plays a protective role against many coastal hazards, including sea-level-rise, changes in rainfall patterns, and the increased frequency and severity of extreme events, such as droughts, floods and cyclones.[30,31] Coral reefs, mangroves,

29 Storlazzi, C. D. , Gingerich, S. B. , Van Dongeren, A. , Cheriton, O. M. , Swarzenski, P. W. , Quataert, E. , Voss, C. I. , Field, D. R. , Annamalai, H. , Piniak, G. , & McCall, R. B. (2018). Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding. Science Advances, 4(4). https://doi.org/10. 1126/sciadv. aap9741

30 Agardy, T. , Hicks, F. , Nistharan, F. , Fisam, A. , Abdullah, A. , Schmidt, A. , & Grimsditch, G. (2017). Ecosystem Services Assessment of North Ari Atoll Maldives. IUCN. https://portals. iucn.org/library/sites/library/files/documents/2017-003. pdf

31 MEE. (2016). National Adaptation Program of Action: Republic of Maldives. (2016). https://unfccc. int/resource/docs/napa/mdv01. pdf

Coral reefs are the most important driver of the Maldives' coastal resilience and the country's continued existence. The flood damage to people and buildings that coral reefs prevent is valued to be the equivalent of 8 percent of GDP in 2021.

and seagrass support shorelines and navigation channels, help reduce coastal erosion, and protect land, people, and property against storm surges. Natural capital, including coral reefs, mangrove forests, seagrass beds, and algae, are thus fundamental for the Maldives' resilience.

Coral reefs are by far the most important driver of the Maldives' coastal resilience and the country's continued existence. The flood damage to people and buildings that coral reefs prevent is valued at US$ 442 M per year, equaling 8 percent of GDP in 2021 (see Footnote).[32] This value reflects the national importance of coral reefs in terms of coastal resilience of the Maldives. Coral reefs are also the reason why the country continues to exist (see Section 2.1.1). Without the sand produced through bioerosion and action of corallivores that inhabit the reefs, the Maldives would not be suitable for human habitation. Coral sands represent 90 percent of the sediments that formed the islands of the Maldives,[33,34,35] and the ability of islands to adapt to sea-level rise is critically dependent on this ecosystem service.

Mangroves stabilize shorelines and navigation channels and prevent the inundation of coastal buildings.

Mangroves stabilize shorelines and navigation channels and prevent the inundation of coastal buildings.[36] These stabilization services reduce the need for beach renourishment, dredging, and maintenance engineering. Mangroves are also important buffers against catastrophic flooding caused by tidal waves and cyclones, although the latter is rare in the Maldives.[37,38] Mangroves in the North Atlantic Basin have been estimated to provide flood protection benefits whose value exceeds $US 65 billion per year.[39] Globally, if mangroves were lost, 15 million more people would be flooded annually across the world.40

32 World Bank estimate. Flood damages consist of the annual damage to people and built capital that would unfold without any coral reefs. The damages to people are calculated by multiplying the annual number of people that would be additionally flooded without coral reefs (Beck et al. Nat. Comm.) with the Value of a Statistical Life estimated with a meta-regression function that is based on 303 VSL estimates (Milligan et al. Accident Analysis & Prevention). The damages to built capital are calculated by multiplying the percentage of the country that would be additionally flooded without reefs (Beck et al. Nat. Comm.) with the monetary value of built capital in the country (CWON 2021).

33 Perry, C. T. , Kench, P. S. , Smithers, S. G. , Riegl, B. , Yamano, H. , & O'Leary, M. P. (2011). Implications of reef ecosystem change for the stability and maintenance of coral reef islands. Global Change Biology, 17(12), 3679–3696. https://doi.org/10. 1111/j. 1365-2486. 2011. 02523. x

34 Perry, C. T. , Murphy, G. , Graham, N. a. J. , Wilson, S. K. , Januchowski-Hartley, F. A. , & East, H. K. (2015). Remote coral reefs can sustain high growth potential and may match future sea-level trends. Scientific Reports, 5(1). https://doi.org/10. 1038/srep18289

35 Li, Y. , Zou, X. , Ge, C. , Tan, M. , Tang, M. , Liu, X. , Wang, L. , Liu, Y. , & Wang, X. (2020). Age and sedimentary characteristics of beach sediments from Yongle Atoll, South China Sea: Implications for sediments supply in a coral reef system. Journal of Asian Earth Sciences, 187, 104083. https://doi.org/10. 1016/j. jseaes. 2019. 104083

36 Ellison, J. C. (2012). Climate Change Vulnerability Assessment and Adaptation Planning for Mangrove Systems. Washington, DC: World Wildlife Fund (WWF)

37 Arkema, K. K. , Guannel, G. , Verutes, G. M. , Wood, S. A. , Guerry, A. D. , Ruckelshaus, M. , Kareiva, P. , Lacayo, M. , & Silver, J. M. (2013). Coastal habitats shield people and property from sea-level rise and storms. Nature Climate Change, 3(10), 913–918. https://doi.org/10. 1038/nclimate1944

38 Taillie, P. J. , Roman-Cuesta, R. M. , Lagomasino, D. , Cifuentes-Jara, M. , Fatoyinbo, T. , Ott, L. , & Poulter, B. (2020). Widespread mangrove damage resulting from the 2017 Atlantic mega hurricane season. Environmental Research Letters, 15(6), 064010. https://doi.org/10. 1088/1748-9326/ab82cf

39 Menéndez, P. , Losada, I. J. , Torres-Ortega, S. , Narayan, S. , & Beck, M. (2020). The Global Flood Protection Benefits of Mangroves. Scientific Reports, 10(1). https://doi.org/10. 1038/s41598-020-61136-6

40 ibid

Seagrasses are the most extensive marine vegetated ecosystem in the Maldives and contribute significantly to reducing wave energy...and velocity and in turn ameliorate coastal erosion.

In Southeast Asia, the value of mangroves in terms of coastal protection was estimated at US$ 367,900-470,000 per km2.[41,42]

Seagrasses are the most extensive marine vegetated ecosystem in the Maldives and contribute significantly to reducing wave energy. Seagrass beds stabilize bottom sediments and reduce wave energy and velocity and in turn ameliorate coastal erosion.[43] At the same time, they are also key habitats for fish and other marine species.

Algae also play a role in shoreline building in the Maldives. There is a diversity of macro-algae in the Maldives, with some reef zones hosting 38 species on average. Together with coral sands, calcifying algae like Halimeda and Acetabularia, contribute to sediment production in the Maldives. Furthermore, Coralline algae are the primary contributors to the structure of coral reef ecosystems. Additionally, they help maintain the pH balance of seawater, which is essential for the health of reef organisms. Without the deposition of calcium carbonate by coralline algae and corals, coral reefs would not exist.

Coral reef health is affected by climate-induced factors such as rising ocean temperatures, ocean acidification, and sea-level rise. At the same time, they are also affected by infrastructure construction, sand mining, reef entrance blasting, dredging, and pollution.

Coral reefs, mangrove forests, and other ecosystems have been reported locally to have reduced the impact of the 2004 tsunami wave in the Maldives.[44] This was the case in the island of Kendhikulhudhoo (Noonu Atoll), where mangroves are in an islet depression (known locally as kulhi) and absorbed much of the impact of the tsunami, preventing the loss of human lives and destruction of property.[45]

Unsustainable natural capital use has direct negative implications for climate vulnerability, requiring them to be addressed jointly. Coral reef health is affected by climate-induced factors such as rising ocean temperatures, ocean acidification, and sea-level rise. At the same time, they are also affected by infrastructure construction, sand mining, reef entrance blasting, dredging, and pollution.[46] The loss of reefs threatens the competitive advantage of the country's tourism, and fisheries, and undermines its resistance to storms.[47] There have been several bleaching and coral mortality events in Maldives. The latest El Niño damage in 2016 bleached 73 percent of all 71 sampled coral

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41 McIvor, A. , Spencer, T. J. , Möller, I. , & Spalding, M. (2012). Storm surge reduction by mangroves. The Nature Conservancy and Wetlands International. http://repository. tudelft. nl/assets/uuid:79fe752e-ce52-4bf6-a45c-2847bead07ab/storm-surge-reduction-by-mangroves-report. pdf

42 United Nations Environment Programme. (2014). The importance of Mangroves to people: A call of action. https://www.unep.org/resources/report/importance-mangroves-people-call-action-0

43 UNESCO World Heritage Centre. (n.d.). World Heritage Marine Programme. https://whc. unesco.org/en/marine-programme/

44 UNEP (2005) Maldives post-tsumami environmental assessment. UNEP, Nairobi, Kenya, p 19

45 Blue Peace Blog. (2010). Mangroves that saved Kendhikulhudhoo from tsunami are under threat now. Biodiversity. http://www.bluepeacemaldives.org/blog/biodiversity/kendhikulhudhoo-mangroves-under-

46 Asian Development Bank. (2021). Climate Risk Country Profile: Maldives. https://www.adb.org/publications/climate-risk-country-profile-maldives

47 The coral reef structure buffers shorelines against waves, storms, and floods, helping to prevent loss of life, property damage, and erosion. When reefs are damaged or destroyed, the absence of this natural barrier can increase the damage to coastal communities from normal wave action and violent storms.

The latest El Niño damage in 2016 bleached 73 percent of coral sites in the Maldives.

sites in the Maldives.[48] Coastal erosion is also driven by both sea-level rise and infrastructure development. The need for climate-proofing existing and planned infrastructure is critical, including housing, which is in short supply, expensive, and vulnerable.

1.4 Past development yielded staggering improvements of Physical Capital and Human Capital in the Maldives, but it came at a cost to Natural Capital

To understand whether a country is developing sustainably, it is important to understand its three main national wealth classes: human capital, physical capital, and natural capital

The continuous growth in the Maldives' GDP does not necessarily reflect a path of sustainable economic growth. GDP indicators measure economic output by summing the monetary value of all goods and services consumed by final users.[49] Economic output is produced with a country's assets– such as machinery, skilled labor, and natural resources– which can depreciate or deplete over time. Yet, asset depreciation and depletion, especially that of Natural Capital, are not included in GDP measures, or related measures looking at economic flows.

To understand whether a country is developing sustainably, it is important to understand its three main national wealth classes: human capital, physical capital, and natural capital. Aside from looking at economic flows (such as GDP and income) to understand whether a country such as the Maldives is developing sustainably, it is important to understand how these main asset classes have changed (depicted in figure 3). Examples of physical (or produced) capital include human-made goods and infrastructure such as roads, ports, and telecommunication infrastructure. Human capital includes the health status, knowledge, and skills that people develop during their lives. Finally, examples of natural capital include clean oceans, marine wildlife, and trees.[50] Natural capital refers to the potential societal value derived from the future services and products that natural resources can offer. Such services and products encompass fishery resources, recreational diving and snorkeling opportunities, flood control, and erosion prevention.

In the Maldives, human and produced capital have consistently increased over the past decades. Human and produced capital increased at staggering rates between 1995 and 2018 (see figure 4), by more than 300 percent and 1000 percent, respectively; according to the Changing Wealth of Nations (CWON) database, which has been maintained by the World Bank for several decades.

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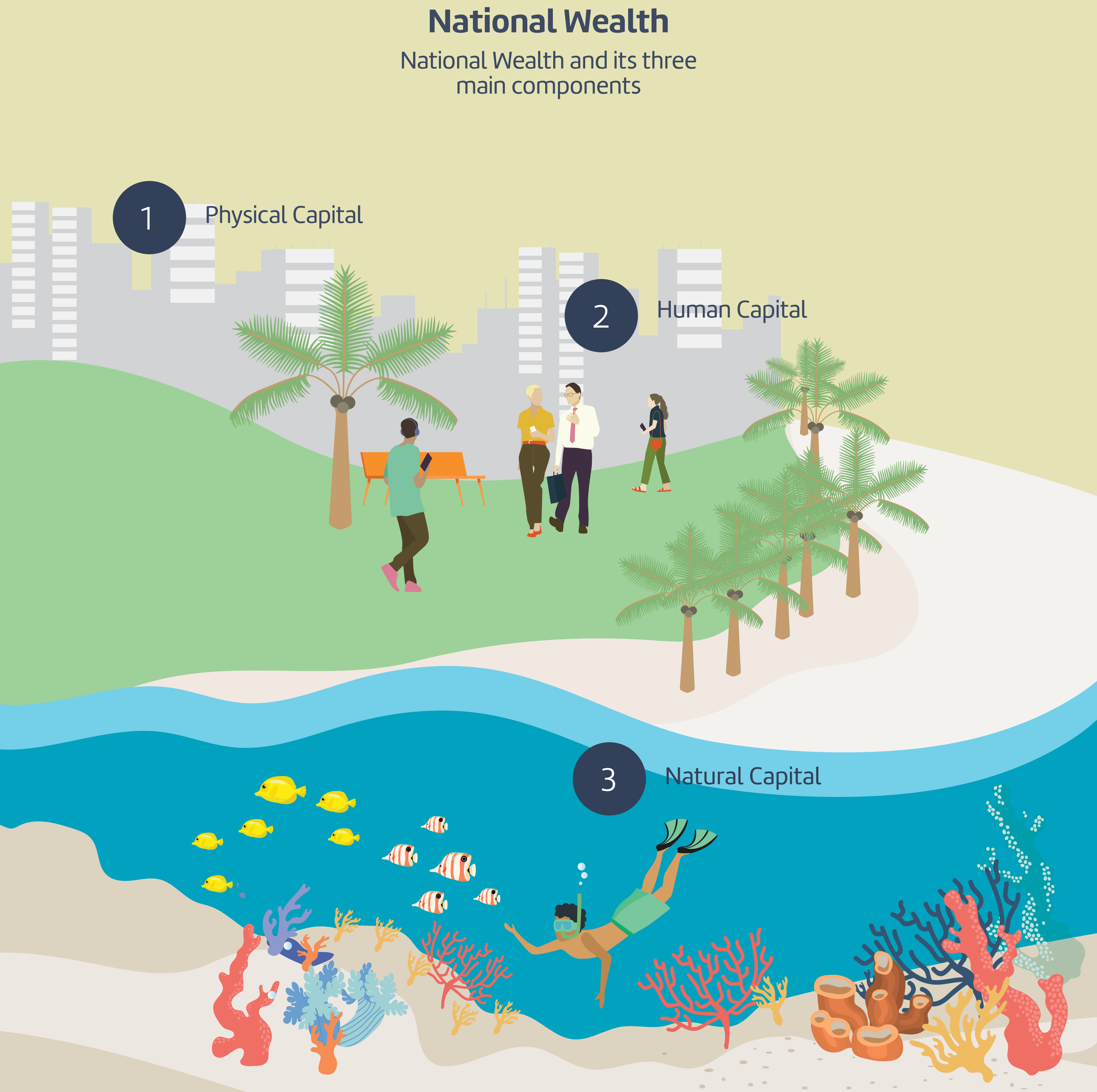
48 International Union for Conservation of Nature. (2016). Status of Coral Bleaching in the Maldives 2016. https://portals. iucn.org/library/sites/library/files/documents/2017-025. pdf

49 IMF. (201). Gross Domestic Product: An Economy's All. https://www.imf.org/en/Publications/fandd/issues/Series/Back-to-Basics/gross-domestic-product GDP#: ~:text=GDP%20measures%20the%20monetary%20value, the%20borders%20of%20a%20 country.

50 World Bank. (2022). Changing Wealth of Nations (CWON). https://www.worldbank.org/en/publication/changing-wealth-of-nations

Figure 3. Whether a country develops sustainably depends on three main national wealth classes

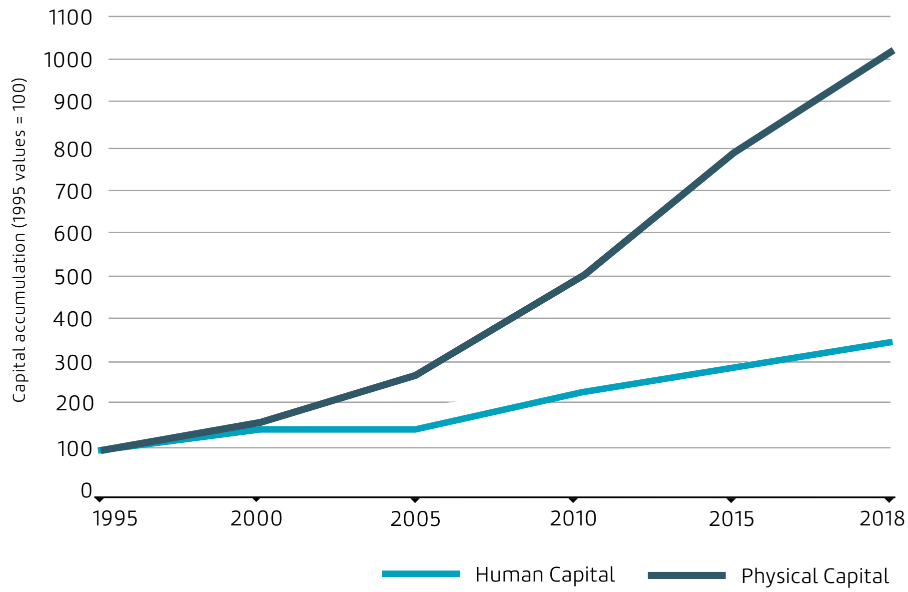


Source: Changing Wealth of Nations (2021) published by World Bank.

Human Capital and Physical Capital have significantly improved in the Maldives while changes in the country's Natural Capital remain largely unmeasured.

Figure 4. Human Capital and Physical Capital have significantly improved in the Maldives while changes in the country's Natural Capital remain largely unmeasured.

The accumulation of human and physical capital according to the Changing Wealth of Nations (2021).



Human Capital and Physical Capital have significantly improved in the Maldives while changes in the country's Natural Capital remain largely unmeasured.

Source: Changing Wealth of Nations (2021) published by World Bank

Virtually all proxy indicators measuring human capital outcomes in the aggregate have been increasing.

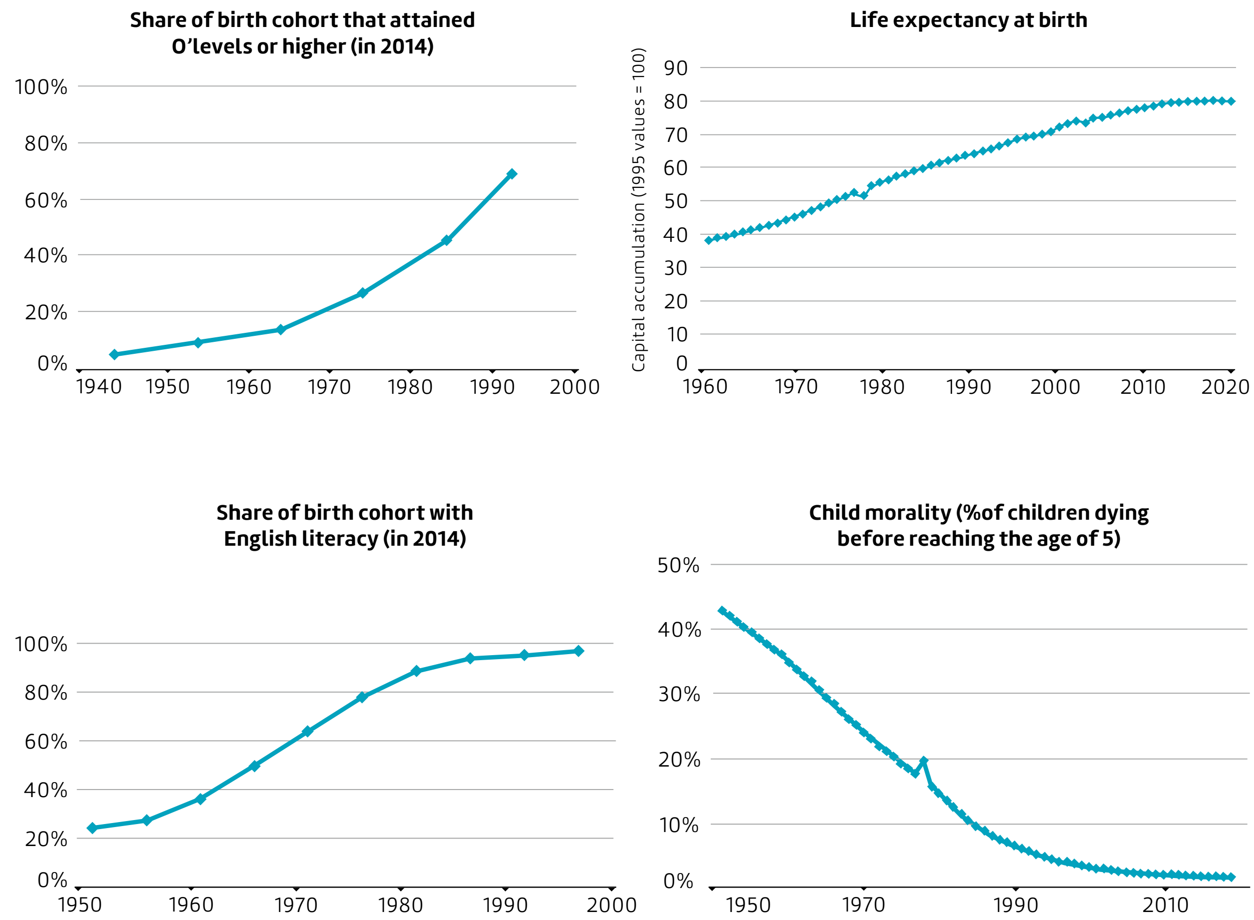
Virtually all proxy indicators measuring human capital outcomes in the aggregate have been increasing. Health indicators show that human capital increased in the Maldivian population between the mid-1900s and early 2000s (see Figure 5). All aggregate human health indicators in the World Development Indicators (WDI) data repository, as well as other indicators show improving trends over the last decades. For example, life expectancy at birth increased from 37 in 1960 to 79 in 2019.[51] Furthermore, the odds of dying under the age of 5 decreased from 44 percent in 1950 to less than 2 percent in 2019.[52] Education-related statistics disaggregated by age also suggest that people who were born in later years accumulated more human capital relative to older generations. Only 5 percent of those born between 1940 and 1950 attained an O'level qualification or higher, while the average for those born between 1990 and 1995 was 68 percent.[53] In addition, the English literacy rate is 25 percent among those born between 1950 and 1954 and 97 percent among those born between 1995 and 1999.

51 World Bank 2022. https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=MV

52 Global Burden of Disease Study 2019. Lancet. 2020 Oct 17;396(10258):1250–1284.

53 Maldives Population and Housing Census 2014 and CIA World Factbook 2015.

Figure 5. Selected indicators of the Maldives' Human Capital stock that have consistently improved in the past decades



Life expectancy at birth in the Maldives (upper left), Life expectancy (upper right), Educational attainment (bottom left), and Odds of dying under the age of 5 in the Maldives (bottom right).

Source: World Bank 2022; Own calculations based on Maldives Population and Housing Census 2014 and CIA World Factbook 2015; Global Burden of Disease Study 2019.

The increase of produced capital in the Maldives is evident from the expansion of airports, seaports, terminals, access to electricity, and other built infrastructure.

The increase of produced capital in the Maldives is evident from the expansion of airports, seaports, terminals, access to electricity, and other built infrastructure. The country improved its international and regional connectivity by opening 17 airports between 1966 and 2022.[54] In addition, the share of the Maldivian population with access to electricity increased from 84 percent in 2000 to 100 percent in 2014, and the number of broadband internet connections increased from 190 in 2002 to 63,685 in 2020 (see Figure 6, which shows a selection of indicators).[55,56]

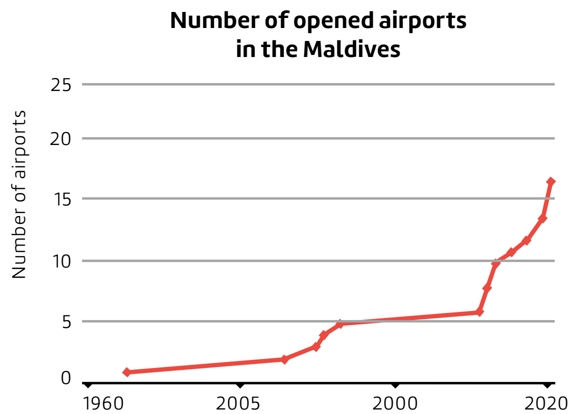
54 World Bank calculations based on data from Island Aviation Services Ltd (2022) and other publicly available sources.

55 World Bank. (2022). Fixed Broad Band Subscriptions. https://data. worldbank.org/indicator/IT. NET. BBND

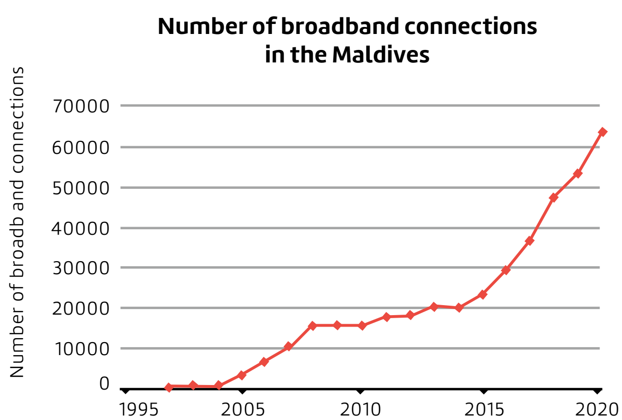
56 World Bank. (2022). Access to electricity (% of population). https://data. worldbank.org/indicator/EG. ELC. ACCS. ZS

Figure 6. Selected indicators of the Maldives' built infrastructure reflect strong accumulation of produced capital

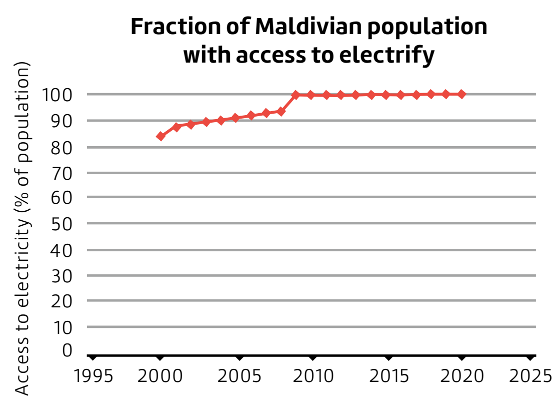
Source: World Bank based on Maldives Port Limited (2022).



Source: World Bank based on Island Aviation Services Ltd (2022) and other publicly available sources.



Source: World Bank (2022). World Development Indicators



Source: World Bank (2022). World Development Indicators

... understanding and tracking natural capital in the Maldives has been difficult due to a lack of comprehensive and readily available natural capital aggregate measures and physical trend indicators.

Unlike physical capital and human capital, understanding and tracking natural capital in the Maldives has been difficult due to a lack of comprehensive and readily available natural capital aggregate measures and physical trend indicators. The evolution of the natural capital stock cannot be as simply demonstrated as the data that underlies natural capital valuations are inadequate; neither the CWON, nor the WDI, nor any other international data repository offers ready insights. This data paucity stems from two primary reasons: (i) the data does not cover the full range of natural capital types present in the Maldives, and (ii) it fails to represent the dependence of economic sectors on the country's blue natural assets. Chapter 2 of this CEA is in large part an attempt to review the data gap and show how natural capital has been faring (indicating that natural capital has significantly deteriorated).

The three main anthropogenic drivers of Blue Natural Capital degradation include coastal development, unsustainable natural resource use, and pollution.

Why is natural capital at the national scale currently inadequately measured? The existing measure, the CWON Natural Capital measure for the Maldives, accounts only for off-shore fisheries, and therefore presenting the value would be grossly incomplete. It fails to include various important Blue Natural Capital components, including the health of coral reefs and reef-associated marine resources (e.g., mangroves, seagrasses, and algae), beach intactness, ocean water quality, and groundwater contamination. The omission of coral reefs and beaches is problematic because a substantial portion of the country's income is obtained from selling recreational experiences to beach and underwater tourists. Coral reefs also provide essential services such as coastal erosion prevention and flood protection. Neither of these ecosystem services are currently represented in the CWON's Natural Capital curve. The omission of ocean water quality prevents an understanding of how much of the tourism and fisheries sectors' revenue is attributable to clean oceans. Finally, the exclusion of rainwater and groundwater in the Maldivian wealth account neglects that many households use rainwater as a source of drinking water and groundwater as a source of washing and bathing.[57] Consequently, there are currently no adequate valuations of natural capital in the Maldives. Chapter 2 looks in depth into the available data sources and makes the determination that most natural resource and environmental data are showing deteriorations. This CEA, and in particular chapter 2, takes stock of the underlying physical data on natural capital that exists in the country to present a more accurate view of the status of Maldives' natural capital.

Pollution poses a significant challenge to the development of a sustainable Blue Economy in the Maldives.

The three main anthropogenic drivers of Blue Natural Capital degradation include coastal development, unsustainable natural resource use, and pollution. Coastal development (such as land reclamation and harbor construction), and other uses[58] of the coastal and marine areas have had significant negative impacts on the natural environment. Insufficient solid-waste and liquid-waste management further exacerbate the pressures on natural resources, leading to significant deterioration. Finally, mal-adaptation to climate change and disaster risks have also had significant unintended impacts (e.g., coastal protection infrastructure on one island leading to significant adverse coastal erosion on others). The degradation challenges include coastal erosion (in 2014, 38 percent of the inhabited islands reported severe erosion),[59] coral reef degradation,[60] and coastal pollution.[61] These challenges manifest in the form of coastal erosion, coral reef degradation, and coastal pollution, which are

57 UNFCC. (2006). National Adaptation Program of Action. https://unfccc.int/resource/docs/napa/mdv01.pdf

58 Examples include anchoring of fishing vessels on or close proximity to corals during active reef fishing, which if not done carefully might lead to localized impacts on the corals. While the traditional reef fishing (undertaken with small light boats) was not expected to have any such impacts, reef fishing has expanded, and such anchoring cannot be ruled out, even if there is not sufficient data or systematic report on this. This is a potential area of investigation by MoFMRA/MMRI to ensure that reef fishing itself does not create impacts on corals.

59 Green Climate Fund (2017). Building Climate Resilient Safer Islands in the Maldives. Green Climate Fund. https://www.greenclimate.fund/document/building-climate-resilient-safer-islands-maldives-0

60 Montefalcone, Morri, C. , & Bianchi, C. N. (2020). Influence of Local Pressures on Maldivian Coral Reef Resilience Following Repeated Bleaching Events, and Recovery Perspectives. Frontiers in Marine Science. https://doi.org/10. 3389/fmars. 2020. 00587

61 Royle et al. 2022. Plastic Drawdown: A rapid assessment tool for developing national responses to plastic pollution when data availability is limited, as demonstrated in the Maldives. Glob. Env. Change, 72, 102442.

discussed in detail in chapter 2 of the report.

Waste generation in the Maldives is among the highest in the South Asia region and Small Island Developing States (SIDS), with approximately 3.5 kg of waste per tourist per day and 1.7 kg per day per capita in Malé (0.8 kg per capita in other inhabited islands).

Photo Description: The condition of the Thilafushi waste dump in 2015, prior to upgrades completed in the last decade. © World Bank

Pollution poses a significant challenge to the development of a sustainable Blue Economy in the Maldives. The growing population and increasing number of tourists have contributed to higher levels of pollution and waste, a trend that is expected to continue with the surge in tourism post COVID-19. Waste generation in the Maldives is among the highest in the South Asia region and Small Island Developing States (SIDS), with approximately 3.5 kg of waste per tourist per day and 1.7 kg per day per capita in Malé, the capital city (0.8 kg per capita in other inhabited islands).[62] Moreover, waste generation is trending upwards. In the capital Malé, waste quantities increased by 155 percent between 2004 and 2014.[63] At the same time, waste pollution has a negative impact on aquatic ecosystems and the economic benefits they offer in the tourism sector. Ocean plastics are a significant tourist deterrent.[64]

Despite indications of deteriorating natural capital in the Maldives', as reviewed in chapter 2, the lack of adequate data measuring natural capital flows is a key area identified for improvement. For example, the reefs in most Maldivian islands are adversely affected by an increasing human footprint (including

62 UNESCAP (2021). Maldives National Waste Accounts 2018 and 2019. https://www.unescap.org/sites/default/d8files/2021-04/Maldives_National_Waste_Account_Report_2018-19.pdf

63 Ibid

64 Based on Roye et al. 2022 (excludes the estimated 1,000 tons of plastic waste leaking from Thilafushi landfill prior to the recent major upgrade).

The increasing human footprint has a negative impact on reef ecosystem services, including vertical island-building

port construction, harbor basin dredging, and artificial shorelines). The majority of islands have artificially reclaimed land at the expense of reef flats in the past decades. The increasing human footprint has a negative impact on reef ecosystem services, including vertical island-building.[65] However, there is currently no comprehensive monitoring, reporting, and verification (MRV) system in place to track the changes in reefs and other natural assets resulting from these impacts and how they affect the provision of ecosystem services. This lack of data hinders the analysis of economic gains from coastal developments in comparison to the damages caused by the degradation of natural capital.

A flourishing Blue Economy is achieved not only by managing natural resources well, but also by developing human and produced capital in support of the sustainable use of natural capital.

Photo Description: Tourist admiring corals, © Neom from *https://unsplash.com/photos/a-scuba-diver-swims-over-a-coral-reef-FXJf8y_cZA0*

A flourishing Blue Economy is achieved not only by managing natural resources well, but also by developing human and produced capital in support of the sustainable use of natural capital.[66]This is because human and built capital are critical determinants of natural capital preservation. For example, knowledge about reducing waste and the skills to prevent ocean pollution are human capital components that contribute to the preservation of natural capital. Similarly, the sustainable development of built capital, including the adoption of clean energy technologies and minimizing negative impacts on coral reefs during construction projects, contributes to the preservation of natural capital. Therefore, a sustainable Blue Economy strategy needs to take interactions between natural, human, and built capital into account.

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65 Duvat, V. , & Magnan, A. K. (2019). Rapid human-driven undermining of atoll island capacity to adjust to ocean climate-related pressures. Scientific Reports, 9(1). https://doi.org/10. 1038/s41598-019-51468-3

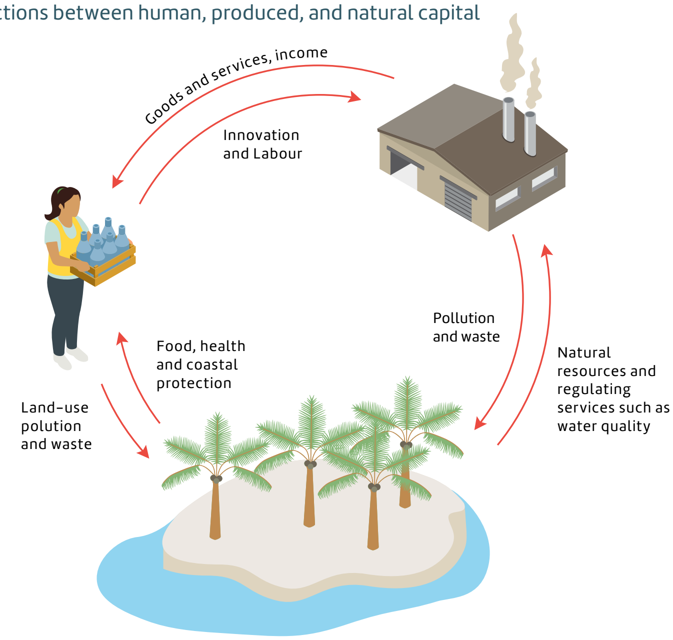
66 Dasgupta, P. (2021). The Economics of Biodiversity: The Dasgupta Review. London: HM Treasury. https://assets. publishing. service. gov.uk/government/uploads/system/uploads/attachment_data/file/962785/The_Economics_of_Biodiversity_The_Dasgupta_Review_Full_Report. pdf

Given the concentration of economic activities that heavily rely on blue natural assets, it is critical to ensure that the Blue Economy sectors are developed sustainably...

Despite its importance, the Blue Economy in Maldives faces pressures from unsustainable development, pollution, and climate change, and therefore needs to be made both more sustainable and climate resilient. Given the concentration of economic activities that heavily rely on blue natural assets, it is critical to ensure that the Blue Economy sectors are developed sustainably and that the natural capital, including marine, coastal, and island ecosystems, continues to provide ecosystem services for current and future generations. The goal is to foster virtuous cycles where natural capital is sustainably managed and its climate resilience is enhanced, rather than falling into vicious cycles where unsustainable management of natural capital exacerbates the impacts of climate change. This CEA report examines the Blue Economy of the Maldives within the context of these virtuous and vicious cycles.

Figure 7. A sustainable economy does not only accumulate natural capital but also human and built capital

Interactions between human, produced, and natural capital



Source: World Bank, based on The Dasgupta Review 2021.

1.5 Objectives and Scope of the Maldives CEA

The objective of this Country Environmental Analysis (CEA) is to assess the environmental and climate challenges that hamper the Maldives' economic development, and to identify opportunities for transitioning to a sustainable and resilient Blue Economy. The CEA focuses on the four main pressures on natural capital: unsustainable coastal development, pollution, unsustainable natural resource use, and climate change. The CEA discusses how the Blue

The objective of this Country Environmental Analysis (CEA) is to assess the environmental and climate challenges that hamper the Maldives' economic development, and to identify opportunities for transitioning to a sustainable and resilient Blue Economy.

Economy of the Maldives can be made more sustainable and resilient in the context of these pressures. The main objective is divided into several objectives (corresponding chapters in parentheses):

Photo Description: Sea Planes docked at the Sea Plane Airport on Hulule Island © World Bank

To understand how natural capital in the Maldives is changing and why it matters (Chapter 2). This objective involves synthesizing available data to analyze the spatial and temporal changes in natural capital and identifying knowledge gaps. It highlights the need for monitoring data on coral reef health, waste pollution, and fish stocks to ensure sustainable growth in the tourism and fisheries sectors. The objective also examines the drivers of natural capital deterioration and barriers to improvements.

To outline opportunities for shifting to a more sustainable and resilient Blue Economy. Opportunities are identified in terms of:

Strengthening natural resource management, (Chapter 2.1), improving fisheries management (Chapter 2.2), strengthening coastal planning and management (Chapter 2.3.), and improving solid- and liquid waste management (Chapter 2.4).

Conservation management (Chapter 3). This chapter focuses on the protection and conservation of marine ecosystems in the Maldives, including discussions on potential ecotourism initiatives.

Natural resource and environmental governance (Chapter 4). This chapter identifies improvement areas for the governance of Blue Natural Capital, which includes a discussion of the role of data collection and Environmental Impact

The CEA addresses critical knowledge gaps in Blue Natural Capital stocks, the ecosystem services they provide, and how these stocks and flows change over time.

Assessments (EIA) in the planning and monitoring of coastal development projects.

Financing options (Chapter 5). The Maldives faces a financing gap for the transition to a Blue Economy, particularly regarding climate adaptation. This options analysis reviews a range of debt and non-debt instruments that can help close the financing gap.

The CEA presents recommendations for a Blue Economy based on the current understanding of environmental and climate issues in the Maldives. With the latest State of the Environment Report published by the GoM in 2016, this CEA takes an important step forward by presenting analyses that incorporate recent developments and up-to-date knowledge. By doing so, the CEA addresses critical knowledge gaps in Blue Natural Capital stocks, the ecosystem services they provide, and how these stocks and flows change over time. Strengthening the environmental and natural resource information bases is also the most important first step towards developing natural capital accounts. The CEA also assesses the vulnerability of Maldivian islands to climate change, including by developing a Coastal Vulnerability Index (CVI). Hence, the CEA also provides critical input to the prioritization of environmental and climate projects, as well as to climate adaptation financing discussions, including in the context of the Green Climate Fund and the recently established COP27 Loss and Damage fund.

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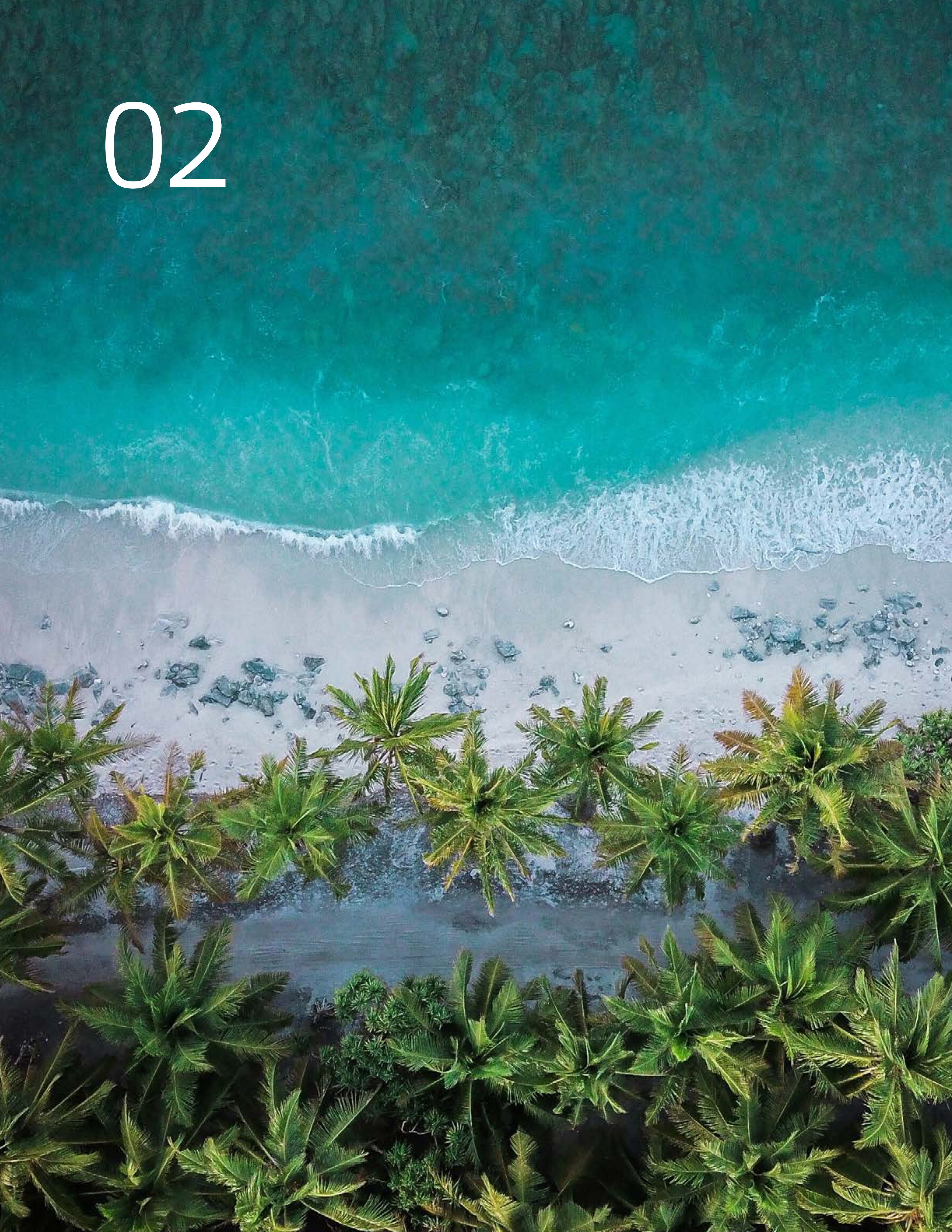

How Blue Natural Capital is Changing, Why It is Changing, and Why this Matters

Blue Natural Capital, including oceanic and coastal ecosystems, is the most prevalent and important source of environmental goods and services in the Maldives. About 99 percent of the Maldives surface is water. [67]The remaining 1 percent is made up of 1,192 islands with an average size of 0.25 km^2. The country's ocean and coastal ecosystems are very diverse as they host 1,100 fish species including sharks, 5 kinds of marine turtles, 21 species of dolphins and whales, and a large variety of coral reefs, mangroves, and seagrass meadows.[68] In comparison with the large Blue Natural Capital stocks present in the Maldives, the terrestrial natural capital stocks are small with relatively low terrestrial biodiversity. Chapter 2 explores the extent to which Blue Natural Capital in the Maldives has improved or deteriorated. It reviews the available evidence regarding the precursors of natural capital valuation, namely changes in the conditions of the country's natural resources. This chapter will therefore provide critical input for natural capital valuations, such as the one that is currently conducted for several natural capital types in the Laamu atoll, which is slated to be integrated into national accounts and development plans.[69]

Blue Natural Capital in the Maldives consists of interrelated components that together contribute to the generation of ecosystem goods and services. For example, coral reefs provide opportunities for reef fishing and recreation, but

67 US Department of State. (2005). Limits in the Seas. No 126. Maldives. Maritime Claims and Boundaries. https://www.state.gov/wp-content/uploads/2019/12/LIS-126.pdf

68 Convention of Biological Diversity. (2022). Maldives - Main Details. https://www.cbd.int/countries/profile/?country=mv

69 MoECCT (2022). Terms of Reference - Consultancy to develop NCA. http:/ww.environment.gov.mv

The changing conditions of Blue Natural Capital cannot be fully understood when its components are analyzed in isolation from each other.

only if the ocean water is of sufficient quality. Plastic and biochemical pollution have particularly adverse effects on reef fish habitat and make beaches less attractive. Reversely, an expanding tourism sector stimulates fishing for the domestic market and contributes to waste that ends up in the oceans.

The tourism sector can thus contribute to fish stock depletion and degraded ocean water. Hence, the changing conditions of Blue Natural Capital cannot be fully understood when its components are analyzed in isolation from each other. The subsections below separately discuss each of the natural capital types for ease of exposition. Figure 8 provides an overview over the main types of Blue Natural Capital in the Maldives and the ecosystem services they provide. Figure 8 also indicates the four main threats to Blue Natural Capital, namely coastal development, pollution, natural resource extraction, and climate change and weather.

Figure 8. The Maldives' natural capital and associated ecosystem services are threatened by multiple stressors.

Natural Capital types and their contributions to Ecosystem Services in the Maldives.

Major NC types in Maldives	Threats: (1) coastal development, (2) pollution, (3) weather & climate events, and (4) natural resource extraction							
Ecosystem services	Coral reefs	Mangroves	Seagrass	Algae	Ocean	Lagoons	Beaches	Groundwater
Recreation (tourism)								
Fish habitat								
Coastal protection/ island formation								
Carbon sequestration								
Freshwater								

Box 2. The Environment and Climate Survey of Resort Islands

To complement the data available for inhabited islands on environmental and climate indicators, original survey work was carried out as part of the CEA. An Environment and Climate Survey of Resort Islands was administered by World Bank and Ministry of Tourism. The survey was deployed to ask resort managers about their perception of environmental and climate issues in the past five years, such as plastic pollution and coastal erosion. They were also asked about their own environmental management practices, including about waste management, coastal protection measures, and environmental conservation and education. The survey was sent out to all 169 operational resorts in February 2023. Responses were obtained from resorts in 11 out of 20 atolls, with an overall response rate of 19%.

The Maldives is home to a remarkable array of marine life, boasting 2031 distinct coral reef sites.

2.1 Marine ecosystems

Among the vast array of Blue Natural Capital types present in the Maldives, there are four important types that are particularly important: coral reef ecosystems, mangrove forests, seagrass meadows, and algae. This section outlines for each type its importance for the Maldives' economy and resilience, how it is changing due to human and climate pressures, and gaps and barriers in conservation management.

2.1.1 Coral reefs

The Maldivian coral reefs, rich with biodiversity, are unique in the world. Coral reefs, integral to the Maldivian marine ecosystem, cover an expansive area ranging from 2,697 to 4,510 km^2.[70,71] These reefs, which account for 3% of the global total, form the 7th largest reef system in the world. Stretching over 820 km from North to South, this extensive reef network is dispersed across the nation's 1,190 islands and 26 natural atolls. Owing to their remarkable biodiversity, the Maldivian reef ecosystems are considered the 5th richest globally.[72] The Maldives is home to a remarkable array of marine life, boasting 2,031 distinct coral reef sites. The biodiversity within these sites includes at least 257 recorded species of soft and stony corals belonging to 57 genera,[73,74] over 1,100 species of fish, 5 species of marine turtles, at least 20 species of marine mammals, 40 species of sharks, and 167 species of birds. However, detailed baseline data for corals, fish, algae occupancy, and macro-invertebrates are not readily available in the public sphere.

Reef ecosystems are fundamental ecosystem service providers. Reefs provide shelter, feeding, and breeding space for a diversity of fauna and associated food webs.

In the Maldives, reef ecosystems are fundamental ecosystem service providers. Reefs provide shelter, feeding, and breeding space for a diversity of fauna and associated food webs. They are also the reason for the Maldives' territorial existence in the face of sea-level rise. Coral sands represent 90 percent of the sediments that build the land in the Maldives, with calcifying algae (Halimeda), foraminifera, and crustaceans playing much smaller roles in the Maldives.[75] Consequently, reefs are included in the Maldives National Development Strategy as one of the five strategic pillars of the Maldives Strategic Action Plan (SAP) for 2019-2023: Blue Economy.[76] The Blue Economy pillar consists of six subsectors: (i) Fisheries & Marine Resources, (ii) Agriculture, (iii) Tourism, (iv) SMEs, (v) Labour, Employment & Migration, and (vi) Economic Diversification.

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70 International Coral Reef Initiative. (2022). Maldives | ICRI. ICRI. https://icriforum.org/members/maldives/

71 MEE (2016). National biodiversity strategy & action plan (2016 – 2025). https://www.cbd. int/doc/world/mv/mv-nbsap-v2-en. pdf

72 IUCN (2022). Maldives launches assessments of 39 coral species. (2022). https://www.iucn.org/story/202211/maldives-launches-assessments-39-coral-species

73 Pichon, M. , & Benzoin, F. (2007). Taxonomic re-appraisal of zooxanthellate Scleractinian Corals in the Maldive Archipelago. Zootaxa, 1441, 21-33. https://mapress.com/zootaxa/2007f/z01441p033f. pdf

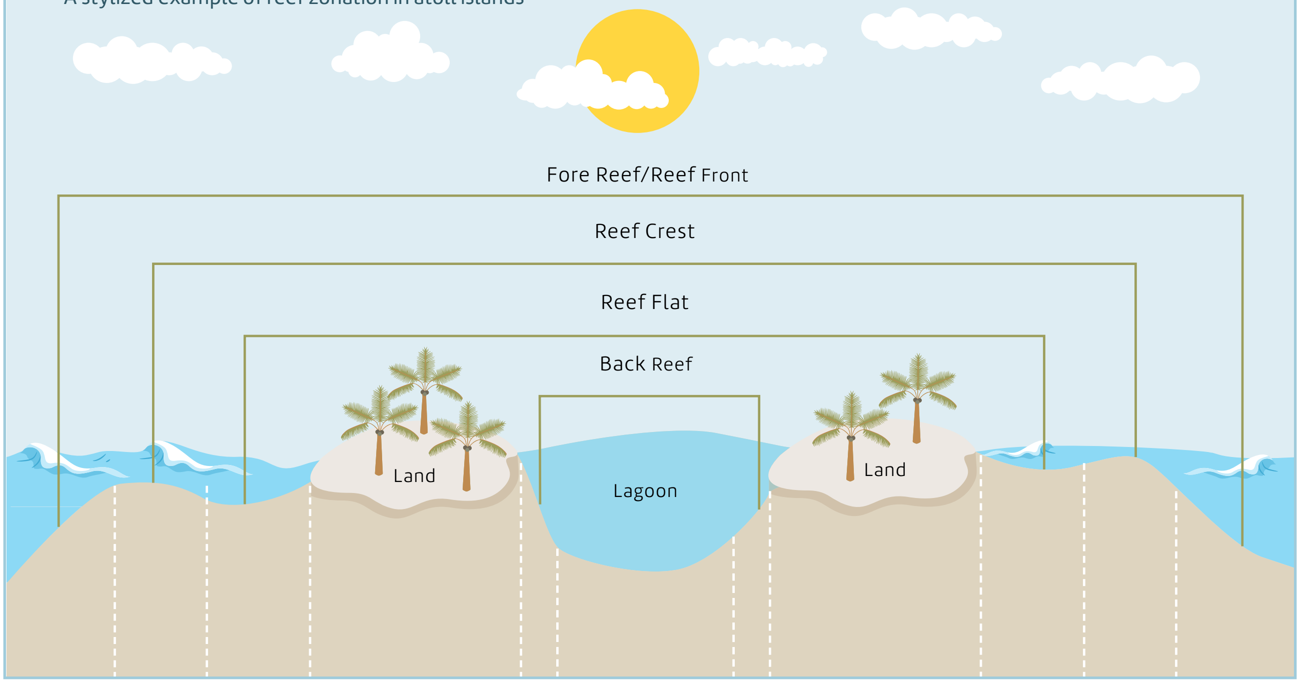
74 IUCN. (n.d.) Maldives. https://www.iucn.org/our-work/region/asia/countries/maldives

75 Perry et al., (2011). https://onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2486.2011.02523.x

76 Government of Maldives. (2019). Strategic Action Plan 2019-2023. https://erc.undp.org/evaluation/managementresponses/keyaction/documents/download/3556

Figure 9. Reefs in atoll islands show zoning with varying coral composition and structure

A stylized example of reef zonation in atoll islands



Source: World Bank adopted from Khaled bin Sultan Living Oceans Foundation.

The composition and structure of corals varies between reef zones due to the impact of waves, temperatures, light, and human impacts.

The Maldives hosts a large variety of coral species. Although baselines and trends for stony coral diversity are not publicly available, some information is published on coral diversity and bleaching by the Maldives Marine Research Institute (MMRI).[77] A 2007 taxonomic baseline list of coral diversity suggests that there are 257 species in 57 genera in the Maldives.[78] This taxonomic compilation highlights the dominance of the Acropora genus in the Maldivian reefscapes (48 species), followed by Fungia (22), Montipora (21), Lobophylia, Porites (14), Goniopora (11), Favia, Favites, Leptoseris, and Pavona (10). Other relevant genera in terms of species diversity include Turbinaria (6), Astreopora (5). Two coral databases (the marinesaver database[79] and the World Register of Marine Species (WoRMS),[80] include some additional Maldivian genera of stony corals: Pocillopora (4), Heliopora (1) Heterocyanthus (2), Isopora (1), and Tubastrea (1). Acroporidae and Pocillporidae families are probably among the most abundant in the Maldives.[81] The composition and structure of corals varies between reef zones due to the impact of waves, temperatures, light,

77 Montano, S. , Siena, F. , & Fathimath Hana Amir, H. F. (2022). Coral Reef Restoration Monitoring Manual. Maldives. https://marhe.unimib. it/publications/manuals-guidelines/

78 Pichon, M. , & Benzoni, F. (2007). Taxonomic re-appraisal of zooxanthellate Scleractinian Corals in the Maldive Archipelago. Zootaxa, 1441(1), 21–33. https://doi.org/10. 11646/zootaxa. 1441. 1. 2

79 Marine Savers. (2023). Maldivian Corals Database. https://marinesavers.com/corals/

80 WoRMS (n.d.). World Register of Marine Species. https://www.marinespecies.org/index. php

81 Garth, J. (n.d.). Decapod Crustaceans inhabiting reef-building corals of Ceylon and the Maldive islands. J. Mar. Biol. Ass. India, 15, 1, 195–212

In general, massive corals tend to be reef-builders in the wave-exposed warm and light waters of the reef flats, while branching corals are more frequent reef-builders in fore-reefs and in areas less exposed to wave-impacts.

and human impacts.[82] As coral sensitivity to environmental and human stressors, including ocean heat waves, varies between species, it is essential to understand how individual coral species respond. However, this information remains scarce in the Maldives, emphasizing the need for more comprehensive data collection to support reef management strategies.[83]Figure 9 illustrates a stylized representation of reef zonation in atoll islands.

Reef-building coral genera identified in Polynesia (Acropora, Montipora, Pocillopora and Porites)[84] probably also dominate in the Maldives. In general, massive corals tend to be reef-builders in the wave-exposed warm and light waters of the reef flats, while branching corals are more frequent reef-builders in fore-reefs and in areas less exposed to wave-impacts. Massive corals (predominantly Porites spp., but also Goniopora spp., Platygyra spp., Goniastrea spp. and Favia spp.) are the dominant contributor to live coral cover on reef flats, comprising 66.3 percent of all live coral recorded on the reef flat in the Mahutigala island (in the southern Huvadhoo,[85] branching corals (including Acropora spp. and Pocillopora sp.) and the Octocoral Heliopora coerulea comprised 13 percent and 12.6 percent of all reef flat live coral, respectively, with the remaining 8.1 percent comprising of small colonies of encrusting, digitate, free-living and tabular corals of varying genera (including Fungia spp., Montipora spp., Porites spp., Galaxea spp., among other unidentified genera). Since February 2022, 39 stony coral species are listed as threatened in the Maldives':[86] 23 critically endangered, 6 endangered, 7 vulnerable and 3 near threatened). Plans of action to protect these species are under development.

Since 2002, more than 10 square kilometers of lagoon and reef area have been altered for land reclamation, representing roughly 3.4% of the entire country's land area.

2.1.1.1 Drivers of coral reef degradation

The most significant threat to the reefs in the Maldives is habitat destruction caused by various development activities, including land reclamation, harbor construction, channel creation, and seawall construction. Since 2002, it's estimated that more than 202 artificial harbors have been built, and over 10 square kilometers of lagoon and reef area have been altered for land reclamation purposes. These activities have significant environmental impacts. For instance, sedimentation and reduced light levels resulting from harbor basin dredging and land reclamation are among the impacts affecting reefs. Large-scale projects like the artificial island of Hulhumale have already resulted in the burial of 8 square kilometers of reef flats.[87] Over the past

82 Khaled bin Sultan Living Ocean Foundation. (2014). Unit 11: Reef Zonation. (2014). https://www.livingoceansfoundation.org/wp-content/uploads/2015/04/U11-Reef-Zonation-Background. pdf

83 MoECCT. (2022). Maldives Red List: Acropora Clathrata. http://www.environment.gov.mv/v2/en/download/17192

84 Pratchett, M. S. , McCowan, D. M. , Maynard, J. , & Heron, S. F. (2013). Changes in Bleaching Susceptibility among Corals Subject to Ocean Warming and Recurrent Bleaching in Moorea, French Polynesia. https://doi.org/10. 1371/journal. pone. 0070443

85 Ryan, E. , Hanmer, K. , & Kench, P. S. (2019). Massive corals maintain a positive carbonate budget of a Maldivian upper reef platform despite major bleaching event. Scientific Reports, 9(1). https://doi.org/10. 1038/s41598-019-42985-2

86 MoECCT. (2022). Maldives Red List. http://www.environment.gov.mv/v2/en/maldives-red-list

87 Miller, N. (2022). A new island of hope rising from the Indian Ocean. BBC Travel. https://www.bbc.com/travel/article/20200909-a-new-island-of-hope-rising-from-the-indian-ocean

Land reclamation and harbor dredging in island reef flats have detrimental impacts on the coastal protection services delivered by the reef-island system in the Maldives.

decade, there has been a 62 percent increase in the number of islands with harbor basins dredged in reef flats, rising from 100 islands to 178 islands out of 608 analyzed islands.[88]

Land reclamation and harbor dredging in island reef flats have detrimental impacts on the coastal protection services delivered by the reef-island system in the Maldives (see Figure 10). These processes lead to the physical degradation of reef flats, impairing their sediment production capabilities. They also disrupt both longshore and cross-shore sediment transport, hindering natural reshaping and replenishment of the islands. Moreover, associated activities such as shoreline armoring, increased sediment mining, and boat channel dredging can destabilize newly reclaimed areas, deplete natural resources, and disrupt sediment production and deposition.[89] Collectively, these actions disrupt the natural balance of coastal and marine ecosystems, posing long-term risks to the Maldivian environment.

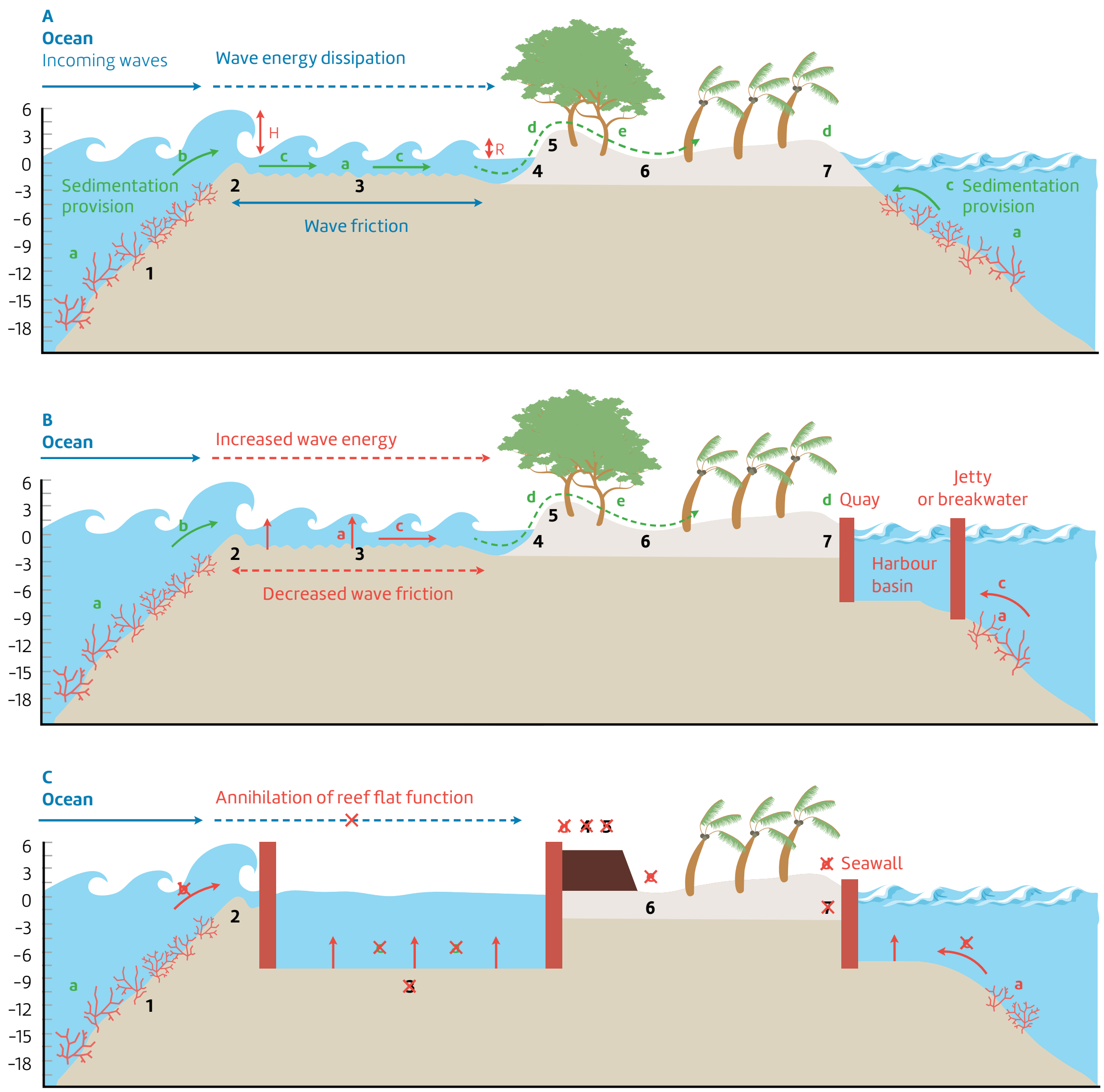
Shoreline armoring, increased sediment mining, and boat channel dredging can destabilize newly reclaimed areas, deplete natural resources, and disrupt sediment production and deposition.

Photo Description: Aerial View of a Island Cleared and being Developed, Maldives © World Bank

88 Magnan, A. K. , & Duvat, V. (2020). Towards adaptation pathways for atoll islands. Insights from the Maldives. Regional Environmental Change, 20(4). https://doi.org/10. 1007/s10113-020-01691-w

89 ibid.

Figure 10. Human disturbances affect reef island dynamics



Morphological features

- Reef structure
- Reef-derived sediments
- Living corals

1 Outer slopes
2 Reef crest
3 Reef flat
4 Ocean beach
5 Beach ridge
6 Inner depression
7 Lagoon beach

Wave parameters

H Inner depression
R Lagoon beach

Vegetation

- Indigenous
- Non-indigenous

Constructional processes

a Sediment production
b Sediment injection
c Sediment transport
d Coastal depositional area
e Washover depositional area

- Daily wave regime
- Extreme wave regime (storm, tsunami)

Human disturbances

- Sediment extraction
- Engineered extraction
- Living corals

Impacts of human disturbances on natural processes

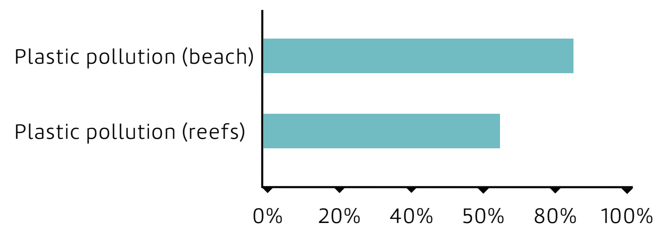
- Undermining of protection service
- Annihilation of natural dynamics
- Partial alteration of constructional processes
- Complete alteration of constructional processes
- Human-induced disappearance of geomorphic feature

Source: World Bank adopted from Duvat and Magnan (2019).

Coral are very exposed to microplastics because they are suspension-feeders, absorbing nutrients through the water. This pollution not only directly compromises the health of the coral reef, but it also increases their vulnerability to other environmental stressors, such as ocean heatwaves.

Coral reef are also threatened by plastic pollution. About two-thirds of the resorts in the Maldives reports observing plastic pollution in coral reefs in the past five years (see Figure 11),[90] and 58 percent of the reef-building corals in the Maldives contain microplastic pollution.[91] Coral are very exposed to microplastics because they are suspension-feeders, absorbing nutrients through the water. This pollution not only directly compromises the health of the coral reef, but it also increases their vulnerability to other environmental stressors, such as ocean heatwaves.

Figure 11. Plastic pollution is reported by a majority of resort islands



Source: World Bank & Ministry of Tourism led Environment and Climate Survery of Resort Islands, 2023.

The most severe bleaching events, tied to global ocean heat waves, occurred in 1998 and 2016, though lesser bleaching was observed in 2003, 2005, and 2010.

The Maldives has been affected by several bleaching events leading to severe coral die-off.[92,93,94] These bleaching events are caused by severe events of ocean heat stress above historic baselines. In the Maldives, these events are related to periodically acute Pacific Ocean ("El Niño") phenomena[95] that combine with the influence of the Indian Ocean Dipole (e.g. 1998, 2016). While these mega heat-stress events have frequencies of 10-15 years and synchronous regional bleaching responses, warmer oceans and more vulnerable reefs are now experiencing localized bleaching at higher frequencies (e.g. 3-5 years), which remain unproperly monitored and reported in the Maldives. When the ocean surface temperature exceeds a certain threshold, significant bleaching and coral mortality occur (see Figure 12). The most severe bleaching events, tied to global ocean heat waves, occurred in 1998 and 2016, though lesser bleaching was observed in 2003, 2005, and 2010 (see Figure 13). Before the devastating heatwave of 1998, the Maldives boasted a coral cover of around 70%. However, the aftermath of the heatwave left only 6.8% of coral cover in shallow reefs (up to 5m depth), indicating considerable coral mortality. It's noteworthy that during this period, atolls under different levels of human pressure experienced similar degrees of coral loss. It took approximately 16

90 World Bank & Ministry of Tourism led Environment and Climate Survey of Resort Islands (2023).

91 Raguso, C. , Saliu, F. , Lasagni, M. , Galli, P. , Clemenza, M. , & Montano, S. (2022). First detection of microplastics in reef-building corals from a Maldivian atoll. Marine Pollution Bulletin, 180, 113773. https://doi.org/10. 1016/j. marpolbul. 2022. 113773

92 Amir, H. (2022). http://mrc.gov.mv/dv/publications/show/status-and-trends-of-hard-coral-cover-derived-from-long-term-monitoring-sites-in-the-maldives-1998-2

93 Montefalcone et al. (2020) https://www.frontiersin.org/articles/10.3389/fmars.2020.00587/full

94 Ibrahim et al. (2016). Status of coral bleaching in the Maldives 2016. Maldives Marine Research Centre.

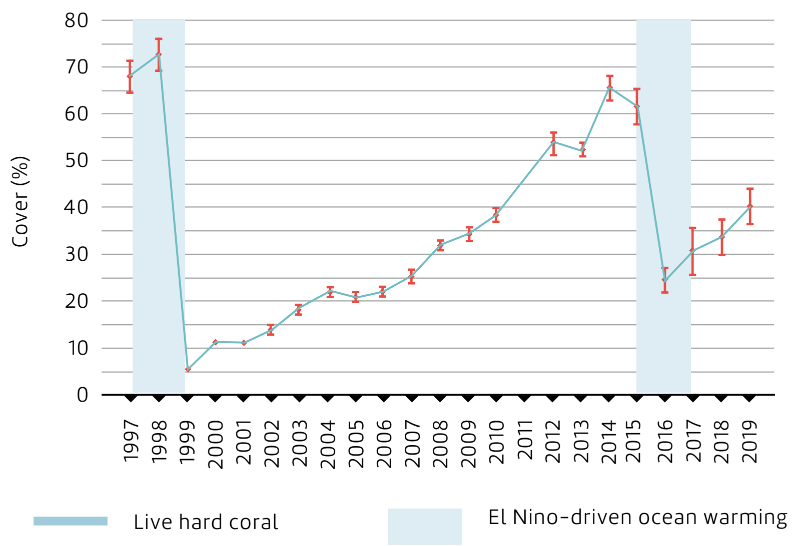
95 National Oceanic and Atmospheric Administration. (2015). El Niño and La Niña. https://www.noaa.gov/education/resource-collections/weather-atmosphere/el-nino

After 1998, it took approximately 16 years for the Maldivian reefs to recover to near pre-bleaching hard coral cover levels, just to be hit again by another severe ocean heatwave in 2016.

years for the Maldivian reefs to recover to near pre-bleaching hard coral cover levels, just to be hit again by another severe ocean heatwave in 2016. Thankfully, the impact of this event was somewhat less damaging than the 1998 incident, with 73 percent of the 71 surveyed sites experiencing severe bleaching, compared to 90 percent coral cover mortality in 1998. Coral cover remains, however, a poor indicator of reef health. Reef management requires data on species responses to bleaching over time, and the responses by the other components of the reefs (fish, algae, and relevant macroinvertebrates (sea urchins and aggressive star fish).

Figure 12. Ocean warming shocks in previous years – 1998 and 2016 – led to large-scale coral mortality

The relationship between El Nino-driven ocean heatwaves and live hard coral cover in Maldives.

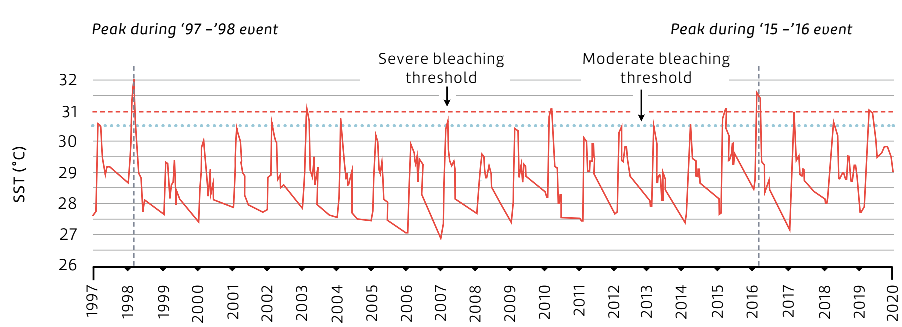


Source: Montefalcone et al. (2020)

Reef management requires data on species responses to bleaching over time, and the responses by the other components of the reefs (fish, algae, and relevant macroinvertebrates (sea urchins and aggressive starfish).

Figure 13. The maximum monthly sea surface temperature exceeded the severe bleaching threshold several times between 1997 and 2020.

Overview of maximum monthly-sea surface temperatures between 1997 and 2020.



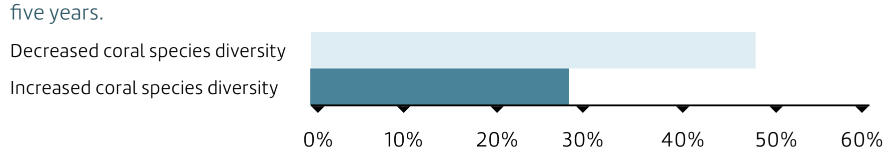
Source: Montefalcone 2020

About 48 percent of resorts have observed a decrease in coral diversity since 2017, while 28 percent have noted an increase.

Similarly, 76 percent of resorts reported bleached corals in nearby coral reefs in or after 2017.[96] The perceived impact on coral species diversity is mixed, probably owing in large parts also to the spatial diversity of the effects on corals. About 48 percent of resorts have observed a decrease in coral diversity since 2017, while 28 percent have noted an increase (see Figure 14). Interestingly, deeper coral sites (7-13m) experienced higher susceptibility to bleaching in 2016, with 77 percent of these sites affected, compared to 66 percent of shallower sites (0-7m). This suggests depth may influence a reef's vulnerability to climate-induced stressors.

Figure 14. Some resorts perceived an increased coral species diversity while others reported a decrease

Share of resorts reporting decreased and increased coral species diversity in the past five years.



Source: World Bank & Ministry of Tourism led Environment and Climate Survey of Resort Islands (2023).

Coastal infrastructure expansion to cater to burgeoning tourism in the Maldives is causing detrimental impacts on marine ecosystems, including issues arising from waste and sewage disposal.

Coastal development negatively affects coral reef health across the Maldives.[97] Tourism is the main driver of economic growth in the Maldives but associated infrastructure development and land reclamation, which promote tourism development, is physically damaging to the reefs. Examples include coral reef damages due to excavation works in the South Ari Marine Protected Area[98] and bridge construction on the Vilimalé reef.[99] Coastal developments also have been linked with more than 50 percent declines in hard coral cover in several Maldivian reefs.[100,101] With hard coral cover being a key indicator of coral reef health, this means that coastal developments are linked with substantial deteriorations in coral reef health.

Coastal infrastructure expansion to cater to burgeoning tourism in the Maldives is causing detrimental impacts on marine ecosystems, including issues arising from waste and sewage disposal.[102] Coral reefs near developed

96 World Bank & Ministry of Tourism led Environment and Climate Survey of Resort Islands (2023).

97 Duvat, V.K.E., Magnan, A.K. (2019). Rapid human-driven undermining of atoll island capacity to adjust to ocean climate-related pressures. Sci Rep 9, 15129

98 Maldives Independent (2015). Reef frequented by whale sharks "destroyed" by resort's excavation work. https://maldivesindependent.com/environment/reef-frequented-by-whale-sharks-destroyed-by-resorts-excavation-work-120434

99 Areeba. (2022). EPA investigates bridge construction vessel grounding on Vilimalé reef. The Times of Addu. https://timesofaddu.com/2022/08/17/epa-investigates-bridge-construction-vessel-grounding-on-vilimale-reef/

100 Nepote, E. , Bianchi, C. N. , Chiantore, M. , Morri, C. , & Manconi, R. (2016). Pattern and intensity of human impact on coral reefs depend on depth along the reef profile and on the descriptor adopted. Estuarine Coastal and Shelf Science, 178, 86–91. https://doi.org/10.1016/j. ecss. 2016. 05. 021

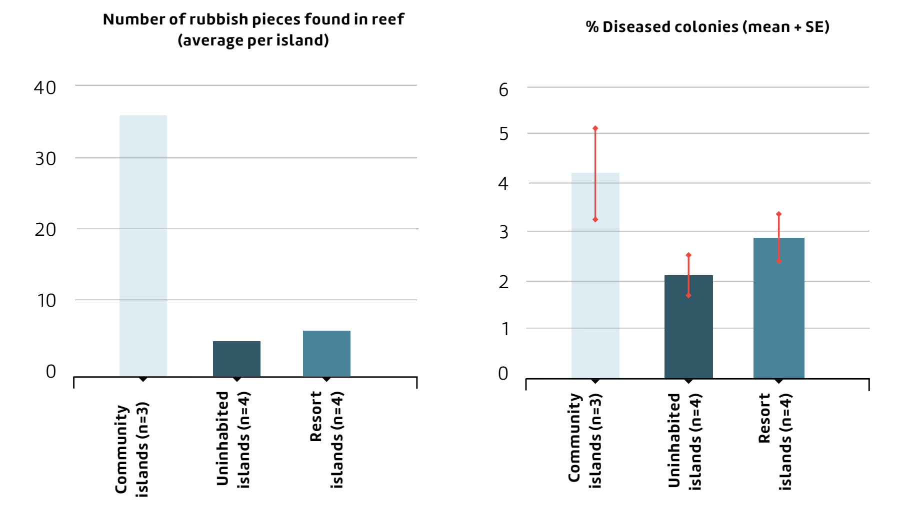
101 Pancrazi, I. , Ahmed, H. , Cerrano, C. , & Manconi, R. (2020). Synergic effect of global thermal anomalies and local dredging activities on coral reefs of the Maldives. Marine Pollution Bulletin, 160, 111585. https://doi.org/10. 1016/j. marpolbul. 2020. 111585

102 Cowburn, B. , Moritz, C. , Birrell, C. L. , Grimsditch, G. , & Abdulla, A. (2018). Can luxury and environmental sustainability co-exist? Assessing the environmental impact of resort tourism on coral reefs in the Maldives. Ocean & Coastal Management, 158, 120–127. https://doi.org/10. 1016/j. ocecoaman. 2018. 03. 025

Reefs close to community islands have a higher incidence of diseased coral colonies (about 4%) compared to those near uninhabited islands (around 2%).

islands appear to be subject to higher quantities of waste and diseases (see Figure 15).[103] For example, nearly 40 pieces of rubbish are typically found in reefs near community islands in the North Ari Atoll, as opposed to less than 10 pieces near uninhabited and resort islands – a difference likely due to regular clean-ups at the latter.[104] Similarly, reefs close to community islands have a higher incidence of diseased coral colonies (about 4%) compared to those near uninhabited islands (around 2%). Thus, coastal development poses a threat to the health conditions of coral reefs, which, in turn, is essential for the continued provision of reef ecosystem services.[105]

Figure 15. Coral reefs near community islands suffer most from human pressures, but coral reefs near resort islands are also affected.



Source: World Bank based on IUCN 2015.

Atolls with a higher human footprint demonstrate more pronounced bleaching responses. In the 2016 heat wave, coral mortality was higher in reefs located in atolls with larger resident populations and more tourists.

Atolls with a higher human footprint demonstrate more pronounced bleaching responses. In the 2016 heat wave, coral mortality was higher in reefs located in atolls with larger resident populations and more tourists.[106] This suggests that human activities not only directly impact coral health but also exacerbate the effects of climate stressors (see Section 2.1.1). Additionally, reefs in the open ocean exhibited lower coral mortality compared to sheltered, lagoon-based reefs, and during the 2016 event, deeper reefs displayed more resistance to oceanic warming compared to their shallower counterparts.[107] Furthermore, reefs in the Ari Atoll experienced an outbreak of crown-of-thorn starfish

103 IUCN (2015). Baseline assessment of coral reefs of North Ari: 2015 Expedition. https://portals. iucn.org/library/sites/library/files/documents/2017-017_0. pdf

104 ibid.

105 Burke, L. , & Spalding, M. (2022). Shoreline protection by the world's coral reefs: Mapping the benefits to people, assets, and infrastructure. Marine Policy, 146, 105311. https://doi.org/10. 1016/j. marpol. 2022. 105311

106 Manconi, R. , Morri, C. , & Bianchi, C. N. (2020). Influence of Local Pressures on Maldivian Coral Reef Resilience Following Repeated Bleaching Events, and Recovery Perspectives. Frontiers in Marine Science. https://doi.org/10. 3389/fmars. 2020. 00587

107 Cowburn, B. , Moritz, C. , Grimsditch, G. , & Solandt, J. (2019). Evidence of coral bleaching avoidance, resistance and recovery in the Maldives during the 2016 mass-bleaching event. Marine Ecology Progress Series, 626, 53–67. https://doi.org/10. 3354/meps13044

Ocean acidification and warming threaten carbonate accretion, leading to potential degradation or even total loss of reefs (in extreme scenarios) by the end of the century.

(COTS) during the 2016 bleaching event, resulting in high degradation. This high variability in bleaching responses reinforces the need for a more comprehensive reef monitoring system.

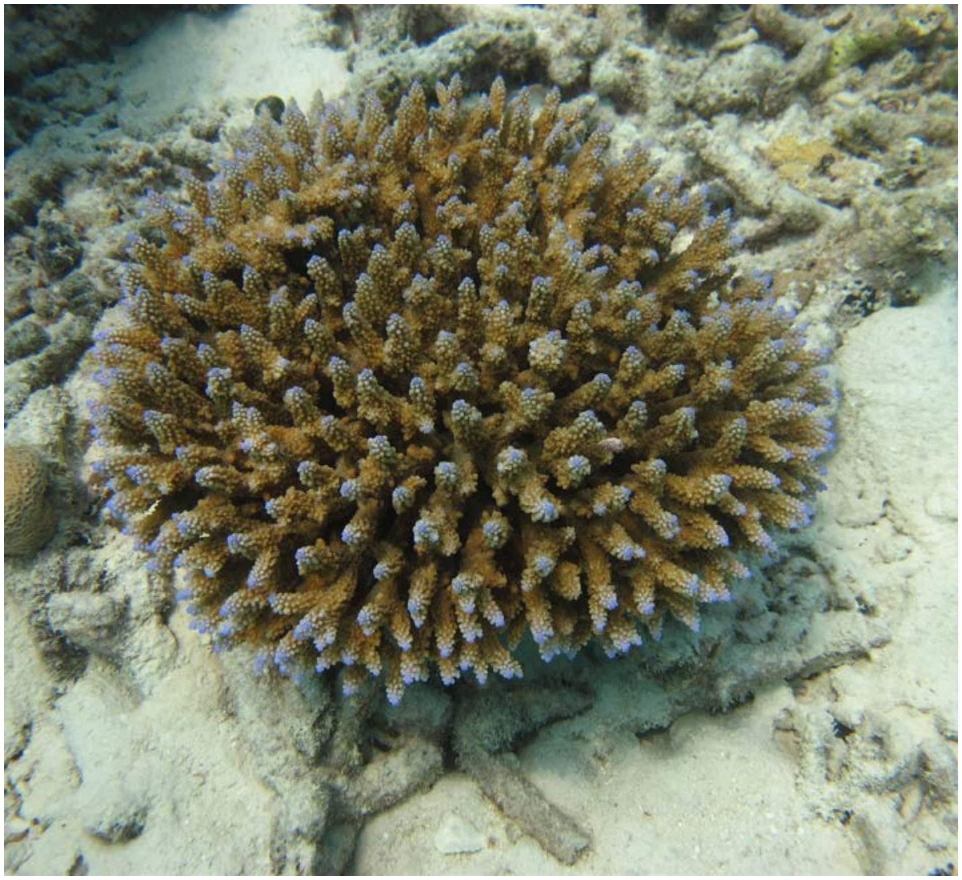


Photo Description: A colony of Acropora latistella coral in the Maldives (Baa Atoll), https://en.wikipedia.org/wiki/File:Acropora_latistella_Maldives.JPG#/media/File:Acropora_latistella_Maldives.JPG

Ocean acidification and warming threaten carbonate accretion, leading to potential degradation or even total loss of reefs (in extreme scenarios) by the end of the century.[108,109] Ocean acidification, a process that significantly reduces carbonate accretion, occurs when the concentration of CO2 in the atmosphere approaches 480 ppm, and the carbonate-ion concentration in most of the global ocean drops below 200 μmol/kg–1. This condition essentially halts the growth and strengthening of coral reefs.[110] Coral mortality from ocean heat waves during bleaching events affects their long-term survival; it's suggested that two severe bleaching events per decade could be a critical threshold.

108 Hoegh-Guldberg, O. , Mumby, P. J. , Hooten, A. J. , Steneck, R. S. , Greenfield, P. , Gomez, E. , Harvell, C. D. , Sale, P. F. , Edwards, A. M. , Caldeira, K. , Knowlton, N. , Eakin, C. M. , Iglesias-Prieto, R. , Muthiga, N. A. , Bradbury, R. , Dubi, A. , & Hatziolos, M. E. (2007, December 14). Coral Reefs Under Rapid Climate Change and Ocean Acidification. Science. https://doi.org/10. 1126/science. 1152509

109 McKay, D. I. A. , Staal, A. , Abrams, J. , Winkelmann, R. , Sakschewski, B. , Loriani, S. , Fetzer, I. , Cornell, S. , Rockström, J. , & Lenton, T. M. (2022). Exceeding 1. 5°C global warming could trigger multiple climate tipping points. Science, 377(6611). https://doi.org/10. 1126/science. abn7950

110 Brachert, T. C. , Corrège, T. , Reuter, M. A. , Wrozyna, C. , Londeix, L. , Spreter, P. , & Perrin, C. (2020). An assessment of reef coral calcification over the late Cenozoic. Earth-Science Reviews, 204, 103154. https://doi.org/10. 1016/j. earscirev. 2020. 103154

Under future climate scenarios, ocean acidification, warming, and associated heat waves could reduce current coral cover in the Maldives by 54 percent and 90 percent, respectively, by 2100.

Such bleaching events also decrease carbonate production and reef accretion, with responses varying across different reef zones.[111] Major declines in shallow fore-reef carbonate budgets have been found in some spots in the Maldives after the 2016 bleaching event. Hence, while carbonate production returned to positive production three years after the 2016 El Niño Southern Oscillation (ENSO) event,112 in some reef sites the immediate response was a shift from strongly net positive carbonate production (mean 5.92 kg CaCO3 m-2 yr-1) to strongly net negative (mean -2.96 kg CaCO3 m-2 yr-1).[113] Combined with human-driven stresses such as declining water quality and overexploitation of key reef species, ocean heatwaves and acidification are driving reefs toward the tipping point of functional collapse. Under future climate scenarios (RCP2.6 and RCP4.5), ocean acidification, warming, and associated heat waves could reduce current coral cover in the Maldives by 54 percent and 90 percent, respectively, by 2100.[114]

Despite some resilience demonstrated by Maldivian reefs, the cumulative effects of climate-induced disturbances and infestations of aggressive marine species may lead to significant reef degradation.

Despite some resilience demonstrated by Maldivian reefs, the cumulative effects of climate-induced disturbances and infestations of aggressive marine species may lead to significant reef degradation. In particular, the Indo-Pacific region, like others, suffers from outbreaks of diseases such as the Crown-of-thorns starfish Acanthaster planci,[115] which can kill up to 90 percent of scleractinian corals. The Maldives reported outbreaks of this starfish in the 1990s, but densities recorded in recent years (2014-15) were the highest in the country's history, resulting in considerable coral mortality.[116]

Effective management and monitoring of coral reefs are crucial in minimizing their vulnerability to ocean heatwaves, with different protection responses having direct effects on ex-ante reef health. This is because various factors, such as species characteristics, wave exposure, and water depth, interact intricately to affect coral resilience to ocean bleaching, thereby influencing their vulnerability and response to environmental stress. While the frequency and intensity of climatic hazards (ocean heat waves) already threaten the stability of reefs, human activities can amplify these threats[117] making them more prone to bleaching during these heat events. As such, the way reefs are managed can either exacerbate or mitigate their vulnerability to these stressors.

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111 Ryan, E. , Hanmer, K. , & Kench, P. S. (2019). Massive corals maintain a positive carbonate budget of a Maldivian upper reef platform despite major bleaching event. Scientific Reports, 9(1). https://doi.org/10. 1038/s41598-019-42985-2

112 ibid.

113 Perry, C. H. , & Morgan, K. (2017). Bleaching drives collapse in reef carbonate budgets and reef growth potential on southern Maldives reefs. Scientific Reports, 7(1). https://doi.org/10. 1038/srep40581

114 Cornwall, C. E. , Comeau, S. , Kornder, N. A. , Perry, C. T. , Van Hooidonk, R. , DeCarlo, T. M. , Pratchett, M. S. , Anderson, K. G. , Browne, N. K. , Carpenter, R. J. , Diaz-Pulido, G. , D'Olivo, J. C. , Doo, S. S. , Figueiredo, J. , Fortunato, S. a. V. , Kennedy, E. V. , Lantz, C. A. , McCulloch, M. T. , González-Rivero, M. , . . . Lowe, R. J. (2021). Global declines in coral reef calcium carbonate production under ocean acidification and warming. Proceedings of the National Academy of Sciences of the United States of America, 118(21). https://doi.org/10. 1073/pnas. 2015265118

115 Pisapia, C. , Burn, D. , Yoosuf, R. , Najeeb, A. , Anderson, K. G. , & Pratchett, M. S. (2016). Coral recovery in the central Maldives archipelago since the last major mass-bleaching, in 1998. Scientific Reports, 6(1). https://doi.org/10. 1038/srep34720

116 ibid.

117 Ibrahim et al. (2016). Status of coral bleaching in the Maldives 2016. Maldives Marine Research Centre.

As coral sensitivity to environmental and human stressors, including ocean heat waves, varies between species, it is essential to understand how individual coral species respond.

There is evidence from other reef systems, such as the Mesoamerican Reef System, that human actions destabilize reefs through factors such as poor water quality, overfishing, and coastal construction.[118,119,120] These activities promote the spread of diseases like Stony Coral Tissue Loss Disease, disturb the balance between fish and the macroalgae they graze on, and physically damage the reefs. Similar effects have been observed in the Maldives.[121,122] The Reef Health Cards from the 2022 Healthy Reefs Initiative for the Mesoamerican Reef Barrier underscore the necessity of rigorous protection in key reef areas, particularly through fishing restrictions, macro-invertebrate control (e.g., starfish outbreaks, sea urchin disappearance) to maintain reef health in the Caribbean. As coral sensitivity to environmental and human stressors, including ocean heat waves, varies between species, it is essential to understand how individual coral species respond. However, this information remains scarce in the Maldives, emphasizing the need for more comprehensive reef management strategies.[123]

Photo Description: Whaleshark in water, Maldives © Naushad Mohamed/ Unsplash

2.1.1.2 Coral reef monitoring and restoration

The Maldives Marine Research Institute (MMRI) carries the official mandate of monitoring, reporting, and managing coral reefs in the country, in collaboration

118 NOAA (2022). NOAA releases Stony Coral Tissue Loss Disease response plan. https://www.noaa.gov/news-release/noaa-releases-stony-coral-tissue-loss-disease-response-plan#:~:text=Stony%20Coral%20Tissue%20Loss%20Disease%2C%20first%20identified%20in%202014%2C%20has,to%20spread%20across%20the%20Caribbean.

119 Healthy Reefs Initiative. (n.d.) Report Cards. https://www.healthyreefs.org/cms/report-cards/

120 Government of Australia. (2019). Great Barrier Reef Outlook Report 2019. https://www2. gbrmpa.gov. au/our-work/outlook-report-2019

121 Duvat, V. , & Magnan, A. K. (2019). Rapid human-driven undermining of atoll island capacity to adjust to ocean climate-related pressures. Scientific Reports, 9(1). https://doi.org/10. 1038/s41598-019-51468-3

122 Report Cards. (n.d.). Healthy Reefs. https://www.healthyreefs.org/cms/report-cards/

123 MoECCT. (2022). Maldives Red List: Acropora Clathrata. http://www.environment.gov.mv/v2/en/download/17192

with EPA (Environmental Protection Agency of the Maldives), MOCCEE (Ministry of Climate Change, Environment, and Energy) and MoFMRA (Ministry of Fisheries, Marine Resources and Agriculture). MMRI runs two interrelated but budget-independent initiatives:

1. The National Coral Reef Monitoring Program (NCRM), established in 1998
2. The National Coral Reef Restoration and Rehabilitation Program, established in 2019.

The institute collaborates with the EPA in monitoring coral reefs in Protected Areas (mandate of EPA), and with international collaborators in coral reef research.

The National Coral Reef Monitoring Program[124]

The Maldives started this program in response to the 1998 mass bleaching event. The National Coral Reef Monitoring Framework is derived from this program and establishes protocols for standardized monitoring in the country, a web-based database, and associated reporting documents.[125] The national monitoring system is run by MMRI personnel and collects data annually from 31 long-term sites: 16 originally established in 1998, 3 new sites in 2021 and 12 new sites in 2011 (see Figure 16). Sites capture shallow and deep locations, as well as inhabited (community, resort) and un-inhabited islands. MMRI monitoring of reefs focuses exclusively on these long-term sites. Reef indicators started with coral cover and fish in 1998, but since 2011 efforts have expanded to include a more coherent set of indicators that offer better information on the health and ecosystem-dynamics of the reef, including stressors. These indicators include:[126]

- reef fish, reef shark, and large-bodied fish abundance, diversity, and biomass
- species composition of bottom (benthic) communities
- the abundance of juvenile corals
- coral cover
- reef rugosity (i.e., shape and area of the reef which provides habitat and resilience)
- the abundance and diversity of benthic macroinvertebrates (such as clams and sea cucumbers)
- water quality

124 Maldives Marine Research Centre. (2014). Coral Reef Research Programme. http://www.mrc.gov.mv/dv/programmes-and-collaborations/coral-reef-research-programme/

125 Maldives Marine Research Centre. (n.d.). The Coral Database. https://www.coraldatabase.gov.mv/

126 Healthy oceans | Noo Raajje | Maldives. (n.d.). NooRaajje. https://www.nooraajje.org/

Figure 16. Not all atolls have long-term coral monitoring sites

Monitoring site locations in the Maldives

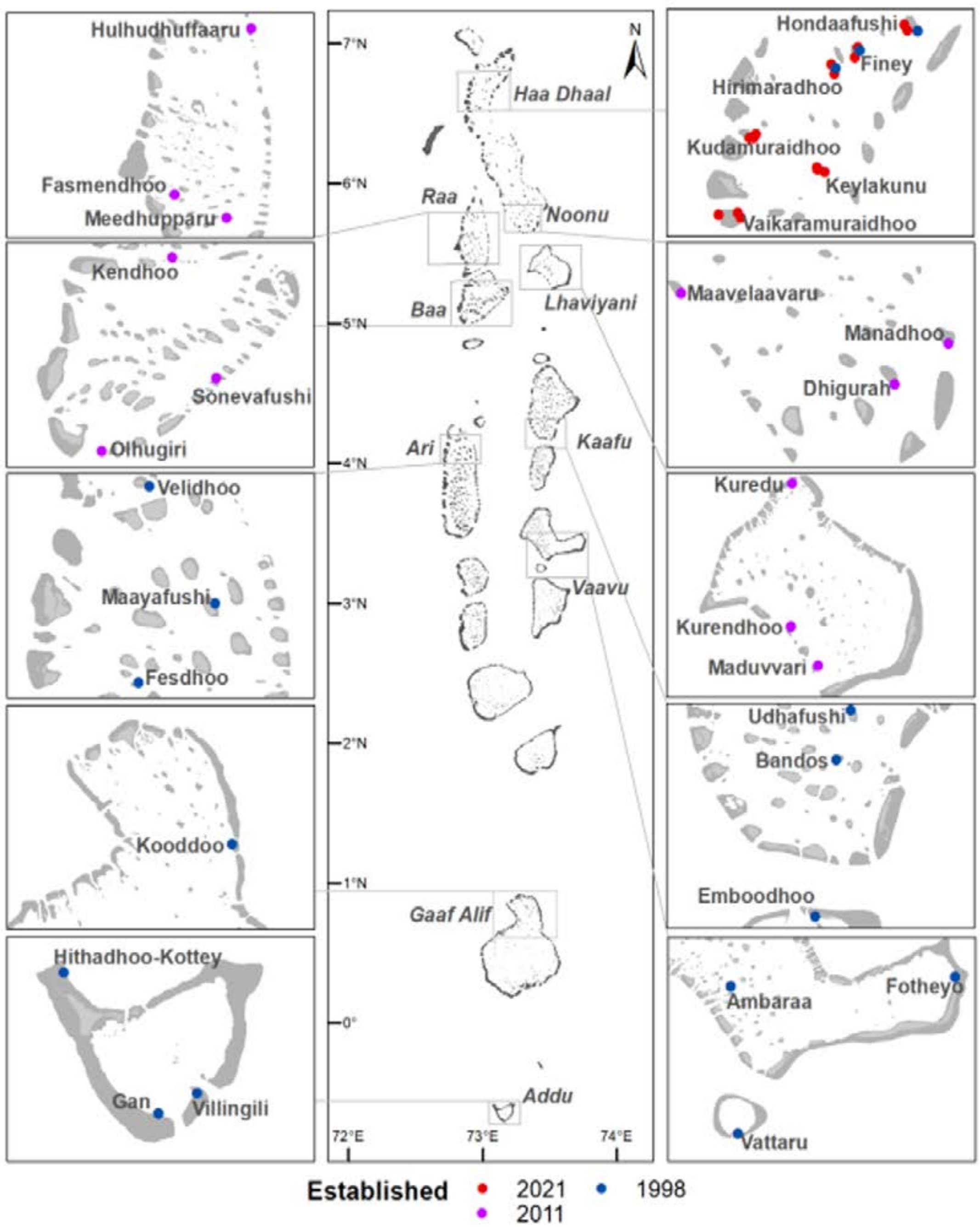

Figure 1. *Long-term monitoring sites throughout the Maldives. The location of each site in each administrative atoll and the year of establishment are shown in each inset. Blue represents sites established in 1998, purple represent sites established in 2011, and red represent sites established in 2021*

Source: Amir (2022).[127]

127 Amir, H. (2022). Status and trends of hard coral cover derived from long term monitoring sites in the maldives- http://mrc.gov.mv/dv/publications/show/status-and-trends-of-hard-coral-cover-derived-from-long-term-monitoring-sites-in-the-maldives-1998-2

There is a need to enhance skills and capacities to improve data collection, consistency, and quality, especially for various biological components of the reefs...

The Government has recently developed an online database repository for citizen science contributions. This data will complement MMRI's data from the long-term monitoring sites.[128] Data from national sites are analyzed by MMRI personnel and transformed into reports like the 2022 assessment on baselines and trends of coral cover: Status and trends of hard coral cover derived from long-term monitoring sites in the Maldives: 1998-2021.[129] As of 2023, reports focusing on fish and other indicators are being produced but have no associated delivery date. MMRI reef data is only made publicly available when the associated reports are published (MMRI pers.com). However, data reporting would need annual or biannual periodicity to facilitate effective and timely management responses.

Despite recent advances in coral reef monitoring in the Maldives, several important gaps and needs remain that require further attention. These gaps and needs are outlined below:

- *Skills and capacity gaps*: There is a need to enhance skills and capacities to improve data collection, consistency, and quality, especially for various biological components of the reefs, such as coral morphology, genus and species identification, as well as the type, abundance, and state of other benthic organisms within the National Coral Reef Monitoring System.[130] Also, Amir (2022) recommends improved coordination among stakeholders of the coral reef monitoring system and strengthening the civil science component of the monitoring program. It should be noted that a national reef monitoring system should rely only on professional data collectors and not on citizen science contributions to guarantee consistency and data quality.

No baseline information or trends are currently publicly available for any indicator of reef health in the Maldives.

- *Lack of baseline information and trends:* No baseline information or trends are currently publicly available for any indicator of reef health in the Maldives (as of Feb 2023). Despite data collection efforts that started in 1998, the Government does not yet provide official statistics on extent, location, baselines or trends of cover, diversity and abundance for coral, fish, and macroinvertebrates, nor water quality. Consequently, official biodiversity and taxonomic lists of stony coral species or fish in the Maldives are not provided. Similarly, no official map with the location of the reefs or total reef area is provided, and no trends other than coral cover have been published. This data gap requires urgent action as it jeopardizes management.

- *Irregular reporting:* To close annual data gaps, more complete and more periodical reporting is needed. Currently, there is only one publication on coral cover, published in 2022, for the 1998-2021 period. As a comparison, other

128 ibid.

129 Amir, H. (2022). Status and trends of hard coral cover derived from long term monitoring sites in the maldives- http://mrc.gov.mv/dv/publications/show/status-and-trends-of-hard-coral-cover-derived-from-long-term-monitoring-sites-in-the-maldives-1998-2

130 ibid.

To capture reef variability in the Maldives, a more representative and comprehensive monitoring system is required.

reef monitoring systems, like the Healthy Reef Initiative in the Mesoamerican Reef Barrier (800km long), collect data annually (using similar indicators and protocols) and offer reader-friendly, graphic, explicative biannual reporting of reef health to guarantee policy action.[131,132]

- *Incomplete reporting of reef health indicators:* Research in other reef monitoring systems shows that coral cover can be a poor indicator of reef health. Coral cover can remain relatively stable while undergoing considerable degradation, as observed in the Reef Health Report of 2022 in the Caribbean. Multiple indicators need to be reported simultaneously, with coral cover presented together with coral diversity, fish, macroalgae, invertebrates, water quality and other relevant indicators of mortality like viruses (which are a major cause of coral disease in the Caribbean reefs).[133]

- *Insufficient number of reef monitoring sites:* To capture reef variability in the Maldives, a more representative and comprehensive monitoring system would require more monitoring sites than the current 31 plots along 800 km. By comparison, a similar latitudinal distribution the Mesoamerican Reef (MAR) counts on 300 long term plots. Similarly, the Noo Raajje expeditions in 2020[134] surveyed[127] reef sites in 15 atolls in the central and northern Maldivian atolls (with additional sites surveyed in 2021 for the southern atolls). The GoM should reflect on what monitoring design would be needed to properly capture reef variability in different habitats, and to assess restoration performance. In this line, Amir (2022) included recommendations to improve the general robustness and representativeness of the system, including by increasing the number of long-term monitoring (LTM) sites in regions with existing LTM sites, establishing new LTM sites, and re-initiating the NCRM program monitoring in the Gaaf Alif region.

- *Inconsistent Methodologies:* Reef monitoring in the Maldives has suffered from inconsistent methodologies, making it challenging to assess trends. Between 1998 and 2021, three main data collection methods were employed at Long long-term monitoring sites:

    a. Triplicate 50m Line Intercept Transects [LIT] (1998-2005).

    b. Quadruplicate 20m Point Intercept Transect [PIT] based on Reef Check (2009-2015), and NCRMF protocols (2016).

    c. From 2017 onwards, predominantly Photo Quadrats [PQ] with CoralNet annotation.

131 Healthy Reefs Initiative. (n.d.) Report Cards. https://www.healthyreefs.org/cms/report-cards/

132 ibid.

133 Healthy Reefs Initiative. (2022). 2022 Report Card on the Health of the Mesoamerican Reef. YouTube. https://www.youtube.com/watch?v=teJ6O-NG8mQ

134 NooRaajje. (n.d.). Coral Reef Assessment. https://www.nooraajje.org/coral-reef-assessment

Maldivian stakeholders would benefit from a nationally calibrated early warning module providing users with information on near-real-time monitoring and predictions of bleaching for Maldivian conditions.

It is recommended that reef monitoring maintains a methodology supported by site inspection. Adopting a technological monitoring with Photo Quadrants is inadequate for tracking reef dynamics, as water quality impacts photo quality.

Maldivian-calibrated Early Warning Systems Module: Maldivian stakeholders would benefit from a nationally calibrated early warning module providing users with information on near-real-time monitoring and predictions of bleaching for Maldivian conditions. The goal is to alert managers, policymakers, and relevant stakeholders to prepare for potential bleaching and to make informed decisions (e.g., closing of the most affected/vulnerable reefs for protection, prioritization for restoration of others, higher control of fishery, taxing on water pollution). Free support can be reached at NOAA's: Coral Reef Watch Satellite Monitoring and Modeled Outlooks.[135] However, this system is based on historic baselines of bleaching and relies on a threshold of warming (8-12 Degree Heating Weeks) that are less useful for reefs that have undergone multiple heat stress events.

Clearer and more effective coordination is needed between MMRI and all the other stakeholders and initiatives monitoring reefs in the Maldives.

Expansion of reef monitoring competences and stakeholder coordination: MMRI monitoring focuses on the long-term sites, while EPA, MOCCEE, and MFMRA are in charge of reef monitoring elsewhere. This requires effective coordination, particularly for the Marine Protected Areas (MPAs), nearly all of which have coral reefs, where EPA operates.[136] This coordination is currently insufficient, and competences overlap. Clearer and more effective coordination is also needed between MMRI and all the other stakeholders and initiatives monitoring reefs in the Maldives (e.g., the Noo Raajje program, the Maldives Coral Institute,[137] the MaRHE center,[138] Marinesavers,[139] resorts, and researchers).

Addressing reef monitoring commitments under international agreements and development programs: Under the Maldives Strategic Action Plan (SAP) (2019-2023), besides committing to protect 10% of the coral area and 20% of wetlands and mangrove area by 2023, the SAP hosts several relevant strategies (e.g strategy 2.1) and targets (2.1-2.3) to promote reef management and monitoring. These include: i) annual monitoring and reporting of at least 7 out of the 15 designated Coral Reef Monitoring sites, ii) continuous monitoring of the overall reef health, and iii) to collate and manage all the reef health data collected through the existing centralized database. While the Government manages a centralized database for the long-term monitoring sites, currently, only citizen science data with unclear quality control are collated and publicly available through an online centralized database.[140] Moreover, annual reporting has not been taking place regularly and has only begun recently (the first

135 NOAA (n.d.). NOAA Coral Reef Watch. https://coralreefwatch. noaa.gov/index. php

136 ICRI (2022). Maldives | ICRI. https://icriforum.org/members/maldives/

137 Maldives Coral Institute. (2023). Maldives Coral Institute. https://www.maldivescoral.org/

138 MaRHE Center. (n.d.). MaRHE Center. https://marhe. unimib. it/

139 Marine Savers. (2023). Marine Savers at Four Seasons Resorts Maldives. Marine Savers. https://marinesavers.com/

140 Government of Maldives. (n.d.). Coral Database. https://www.coraldatabase.gov.mv/

Open-access remote sensing data repositories, such as NASA's Worldview and the EU's Copernicus Hub, can augment the precision and scope of reef monitoring efforts.

report on coral cover is from year 2022, covering the period 1998-2021, and no reporting exists yet for the other indicators, such as for fish).[141]

- *Forge strategic partnerships and explore cost effective technologies:* As the Maldives refines its National Coral Reef Monitoring Framework, numerous opportunities exist to enhance current protocols and data collection. Open-access remote sensing data repositories, such as NASA's Worldview and the EU's Copernicus Hub, can augment the precision and scope of reef monitoring efforts. Integrating satellite imagery and drone-based reconnaissance shows promise in enhancing the detail and immediacy of reef surveillance, especially for variables like coral bleaching and potentially coral diversity, provided the spectral resolution is sufficient. Strengthening partnerships with global academic institutions, such as Professor Chris Perry's Tropical Coastal Geoscience research group at the University of Exeter, and collaborating with private-sector entities like Google, can provide essential expertise and resources. These collaborations can be facilitated through organizations like the World Bank, including platforms like the Sustainable Development Data Lab.

Integrating satellite imagery and drone-based reconnaissance shows promise in enhancing the detail and immediacy of reef surveillance, especially for variables like coral bleaching and potentially coral diversity, provided the spectral resolution is sufficient.

2. The National Coral Reef Restoration and Rehabilitation Program

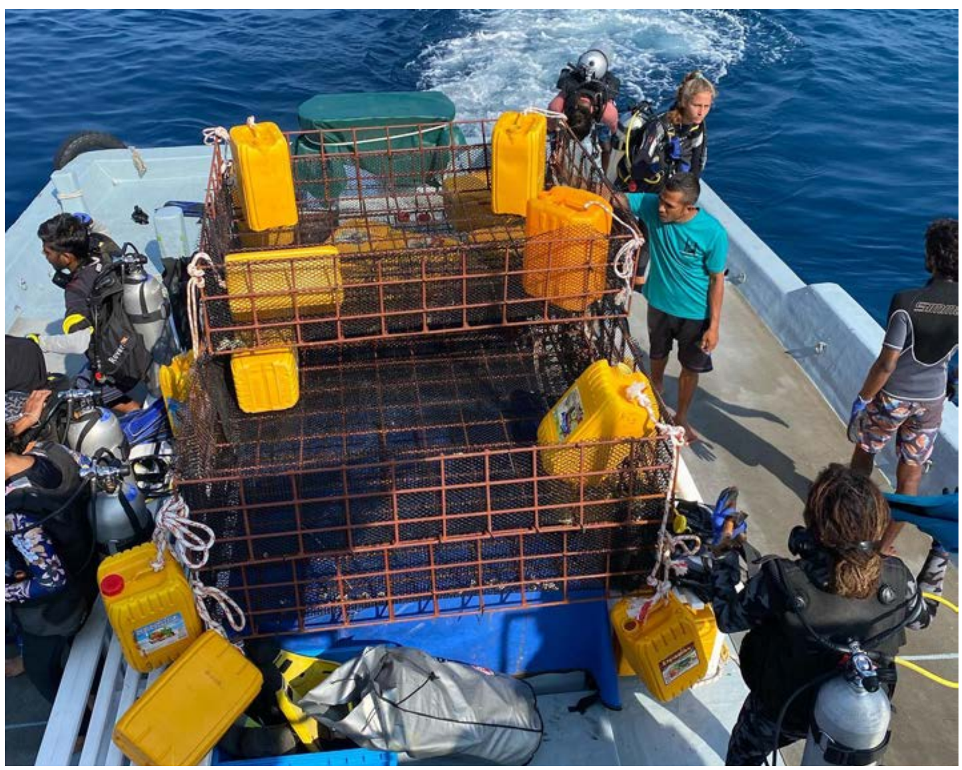

Photo Description: Divers from the Save the Beach NGO, Undertaking Coral Replanting Missions, Maldives © World Bank

141 ibid.

The National Coral Reef Restoration and Rehabilitation Program was established by the Government of Maldives in 2019 and is hosted by the Maldives Marine Research Institute (MMRI).

Box 3. Commitments mentioned in the NBSAP

Target 17: By 2025 pressures on coral reefs and other vulnerable ecosystems due to anthropogenic activities and climate change are minimized

- Assess and identify specific anthropogenic impacts on coral reefs and other vulnerable ecosystems (Number of assessments)
- Identify and assess the impacts on coral reefs and other vulnerable ecosystems due to ocean acidification and elevated sea surface temperature (assessment reports)
- Identify gaps and where necessary formulate and review policies, laws and regulations to decrease anthropogenic and climate change impacts on coral reefs and other vulnerable ecosystems (policies on climate change. Number of new regulations and amendments)

Target 18: By 2025, at least 10 percent of coral reef area, 20 percent of wetlands and mangroves and at least one sand bank and one uninhabited island from each atoll are under some form of protection and management.

- Survey and identify significant ecosystems that needs to be protected (number of survey reports. Significant areas identified)
- Protect and manage representative areas of the identified ecosystems (number and types of protected areas)
- Prepare management plans/ regulations promoting eco-tourism for sustainable management of the protected areas (management plans/ regulations. Reports on increase in richness of ecosystems).

The program aims to develop a nationwide plan to address degraded coral reefs under natural and anthropogenic pressure, combined with the development of mitigation tools to withstand those impacts.

This program was established by the Government of Maldives in 2019 and is hosted by the Maldives Marine Research Institute (MMRI). The program aims to[142]:

Develop a nationwide plan to address degraded coral reefs under natural and anthropogenic pressure, combined with the development of mitigation tools to withstand those impacts;

Address and identify specific information gaps within reef restoration research for the Maldives;

Develop effective sustainable methods and management practices based on the latest available knowledge, tools, and technologies.

142 Montano et al. (2022). https://marhe.unimib.it/publications/manuals-guidelines/

The lack of common data collection protocols has slowed down the progress toward large-scale restoration within the Maldives.

The lack of common data collection protocols has slowed down the progress toward large-scale restoration within the Maldives. There is a growing interest in active coral reef restoration and rehabilitation, including in resort islands. More than half of the resorts conduct coral regrowth and rehabilitation activities.[143] In order to harmonize data collection, enable information exchange, and facilitate the comparison of progress and success in different areas, the MaRHE Center of the University of Milano-Bicocca and the Maldives Marine Research Institute (MMRI) published the Coral Reef Restoration Monitoring Manual in 2022. This protocol is intended to transform efforts that are currently scattered throughout the Maldives into coherent national scale reef restoration action.

In spite of the overarching program for restoration and rehabilitation, it remains unclear what is being done where, how, why, and by whom. The country is missing a clear, logical framework with a well-developed program of action to be publicly shared through the MMRI website to help understand the goals, priorities, areas of action, calendar, and budget needed for restoration and rehabilitation. A clearer legal, governance and financial framework to promote restoration would also be needed.

Gaps and needs for the National Coral Reef Restoration:

Lack of connectivity between the Maldives' coral reef monitoring system and national restoration and rehabilitation program: There exists no available information on how data collected from long-term monitoring sites support restoration-rehabilitation efforts, weakening the science-based potential of the restoration program.

Lack of data sharing on ongoing restoration activities: There is no compiled information on the areas under restoration, nor is there clarity on priority setting for restoration, targeted species, performance indicators, or restoration performance monitoring.

Restoration endeavors differ in scale and effort and are scattered throughout the Maldives with limited connectivity: Lack of connectivity is a significant barrier to upscaling projects and evaluating their effectiveness both locally and at a national scale.

Lack of cooperation and partnership: There is an urgent need to foster intra-governmental, inter-agency, and inter-organizational cooperation and partnerships to mediate limitations related to capacity and resources.

Lack of accountability: Despite laws and regulations protecting coral species within the country, implementation of such laws and regulations is a challenge. There is a need to create infrastructure and capacity that would enable relevant

143 World Bank & Ministry of Tourism led Environment and Climate Survey of Resort Islands (2023).

Marine science should be included more prominently in the curriculum of schools and universities and more skill training opportunities should be created in this field.

laws and regulations to be enforced whilst educating the general public.

Inadequate coverage of marine science in educational and training programs: Marine science should be included more prominently in the curriculum of schools and universities and more skill training opportunities should be created in this field. While there is a course at Maldives National University (MNU) focused on Environmental Management, Marine Science is not sufficiently reflected.

Addressing reef restoration commitments under international agreements and development programs: The Maldives Strategic Plan of Action (2019–2023) includes reef restoration in its Blue Economy Strategy 2 on Expanding reef health assessment, rehabilitation and restoration. The National Biodiversity Strategy and Adaptation Plan (2016–2025) specifies preventing the extinction of local species by 2020, significant restoration of impacted ecosystems by 2025, and the identification of loss rates in natural habitats. The Plan also specifies that the Strategic Environmental Assessments become mandatory for all developmental projects.

2.1.2 Mangroves

Photo Description: Mongroves in Maldvies, © Muhammadh Saamy/Unsplash

The Maldives currently lacks a national map and a land monitoring system detailing the location, extent, and health of its mangrove ecosystems, a critical resource for monitoring changes over time.

The Maldives currently lacks a national map and a land monitoring system detailing the location, extent, and health of its mangrove ecosystems, a critical resource for monitoring changes over time. "Khuli," the local term for mangroves, were estimated to exist on 12% of the Maldives' islands in 2003.[144] However, the Maldives' State of the Environment Report (2016) suggests that only 74 islands hosted mangroves and other wetlands, indicating a potential loss of mangroves on nearly half of the initial 150 islands, and the Maldives' report to the Global Forest Resources Assessment (2015) reported mangrove presence on only 32 islands.[145] The figure below (Figure 17) shows islands with mangrove presence in 2015.

Figure 17. Mangroves are present in at least 32 islands in 2015

Islands with mangrove presence.

Atoll	Island	Atoll	Island	Atoll	Island
K	Gaafaru	Sh	Goidhoo	N	Goidhoo
K	Kaashidhoo	Sh	Milandhoo		Landhoo
Sh	Farukolhu Funadhoo	Sh	Maakadoodhoo		Kedhikolhu
Sh	Maaugoodhoo	Sh	Eriadhoo		Kan'doodhoo
Sh	Funadhoo	Sh	Ekasdhoo	A.dh	Ariadhoo
Sh	Maakandhoo	Ha	Kelai	A.dh	Kulhudhufushi
Sh	Neyo	Ha	Filladhoo	H.dh	Keylakunu
Sh	Feydhoo	Ha	Muraadhoo	H.dh	Neykurendhoo
Sh	Foakaidhoo	Ha	Baarah		
Sh	Kanditheemu	Ha	Thakandhoo		
Sh	Maaugoodhoo	S	Viligili		
Sh	Kekimini	S	Hithadhoo		

Source: Maldives report to the Global Forest Resource Assessment to FAO in 2015

The northern atolls have more mangroves than southern ones, and uninhabited islands possess richer mangrove ecosystems than inhabited ones.

Estimates of mangrove areas, including other wetlands, range between 739 to 900 hectares as presented by the Maldives' report to FAO's Global Forest Resources Assessment (FRA) in 2005 (total forest land) and the Maldives' State of the Environment Report (2016) (mangrove + other wetland area). Official reports like the Maldives' State of the Environment (2016) provide a qualitative description of mangrove locations, stating that northern atolls have more mangroves than southern ones, and uninhabited islands possess richer mangrove ecosystems than inhabited ones.

144 Saleem, A. , & Nileysha, A. (2003). Characteristics, Status and Need for Conservation of Mangrove Ecosystems in The Republic of Maldives, Indian Ocean. Journal of the National Science Foundation of Sri Lanka, 31, 1–2, 201.

145 FAO (2015). Global Forest Resources Assessment. (2015). Country Report: Maldives. https://www.fao.org/3/az267e/az267e. pdf

Table 1. List of core mangrove trees and associated species

#	Dhivehi Name	Common Name	Family	Species	IUCN threat status
1	Randoo	Red Mangrove	Rhizophoraceae	Rhizophora mucronata*	Decreasing-LC
2	Thakafathi	Tall-stilt Mangrove	Rhizophoraceae	Rhizophora apiculata*	Decreasing-LC
3	Bodavaki	Oriental Mangrove / Large-leafed Orange Mangrove	Rhizophoraceae	Bruguiera gymnorrhiza*	Decreasing-LC
4	Bodavaki/	Upriver orange mangrove	Rhizophoraceae	Bruguiera sexangula*	Decreasing-LC
5	Maavasho[1]	Small-leafed Orange Mangrove	Rhizophoraceae	Bruguiera cylindrica*	Decreasing-LC
6	Kandoo	Eye of the Crocodile	Rhizophoraceae	Bruguiera hainesii	Decreasing-
7	Bodukandoo Maakandoo	Berus Mata Buaya (Malay)	Rhizophoraceae	Ceriops tagal*	Critically Endangered
8	Karamana	Yellow Mangrove	Avicenniaceae	Avicennia marina*	Decreasing-LC
9	Baru	Grey Mangrove	Sonneratiaceae	Sonneratia caseolaris*	Decreasing-LC
10	Kulhlhavah	Mangrove (Crab) Apple	Combretaceae	Lumnitzera racemosa*	Decreasing-LC
11	Burevi	Black Mangrove	Meliaceae	Xylocarpus moluccensis*	Decreasing-LC
12	Marugas	Puzzlenut Tree / Cannonball Tree	Sterculiaceae	Heritiera littoralis*	Decreasing-LC
13	Kaharuvah	Looking-glass Mangrove	Lythraceae	Pemphis acidula*	Decreasing-LC
14	Kuredhi	Shrubby Coral Pemphis/ Iron Wood[2,3]	Euphorbiaceae	Excoecaria agallocha*	Decreasing-LC
15	Thela	Milky Mangrove / Blind-your eye Mangrove	Lecythdaceae	Barringtonia asiatica	Decreasing-LC
16	Kinbi	Fish Poison Tree2	Pteridaceae	Acrostichum aureum*	Decreasing-LC
17	Maakeha	Mangrove Fern	Fabaceae	Derris trifoliata*	Stable-LC
18	Thelaviyo	Mangrove Vine / Common Derris	Boraginaceaa	Tournafortia argentea	Stable-LC
19	Boashi	Tree Heliotrope[2]	Malvaceae	Thespesia populnea	Decreasing-LC
20	Hirundhu	Milo[2]	Goodeniaceae	Scaevola taccada	Stable-LC
21	Magoo	Scaevola[2]	Malvaceae	Hibiscus tiliaceus	
22	Dhiggaa	Beach Hibiscus[2]	Pandanaceae	Pandanus tectorius	Unknown-LC
23	Boah'Kashi'keyo	Pandanus/ Thatch screwpine	Pandanaceae	Pandanus odorifer	Unknown-LC
21	Maa'kashi'keyo	Pandanus/ screw pine	Malvaceae	Hibiscus tiliaceus	Unknown-LC
22	Boah'Kashi'keyo	Pandanus/ Thatch screwpine	Pandanaceae	Pandanus tectorius	Unknown-LC
23	Maa'kashi'keyo	Pandanus/ screw pine	Pandanaceae	Pandanus odorifer	Unknown-LC

Source: 15 mangrove species in Sivakumar et al (2018), partly deriving from Nasser et al. (1999). 1 Only found in the island of Fuvahmulah. This raret true mangrove species is a medium sized evergreen tree that grows up to 20m but in Fuvahmulah are only 5 m. These mangroves are found in Dhadimagi Kilhi wetland area, growing in the marshes. The species found in Fuvahmulah is less salt tolerant than the other six species of Bruguiera and grows well in low saline conditions.

Compared to other atolls in the Indian Ocean, the Maldives hosts a rich variety of mangrove species.

While independent global mangrove monitoring systems exist, such as the Global Mangrove Watch (GMW), data remains unreliable for the Maldives due to the relatively small size of mangrove patches. For the Maldives, the GMW geoportal reports 970 hectares of mangroves (2020), with no change over time.[146] Other global databases, such as the European Space Agency (ESA) Worldcover map (10 m pixel resolution, Sentinel 2),[147] poorly classify mangroves, with 328 hectares reported as "mangroves" in 2021. Because ESA's Worldcover is the only digital layer among the mentioned databases, it could perhaps be used to navigate further mapping efforts in the country.

Compared to other atolls in the Indian Ocean, the Maldives hosts a rich variety of mangrove species. Out of the 80 mangrove species found worldwide, 55 species and 22 genera have been reported in the broader Indian Ocean region.[148,149] Notably, up to 15 of the 17 core mangrove species native to this region can be found in the Maldives, the highest in the area. The Seychelles host a distant 9 species, followed by Lakshadweep (4), Chagos Archipelago (2), and the Keeling Islands (2).[150,151,152,153] The number of mangrove species expands to 23 when mangrove associates are also considered (see Table 1). Among these species is the recently discovered bruguiera hainesii, which is a critically endangered Red List mangrove species.[154] The relatively high species diversity in the Maldives can likely be attributed to high habitat diversity fostered by variability in geomorphology, tidal ranges, and ocean conditions.

The northern islands host a larger diversity of mangrove species and larger mangrove forest extents compared to the southern islands. Furthermore, uninhabited islands are richer in mangroves than inhabited islands.[155,156] A much needed updated assessment of mangrove species under the Maldives' Red List is slated to be published in 2023.[157]

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146 GlobalMangroveWatch.(n.d.).Worldwide.https://www.globalmangrovewatch.org/?activeLayers=mangroveextent&category=distribution_and_change&zoom=2

147 European Space Agency (2021). WorldCover 2021. https://worldcover2021. esa. int/

148 Kandasamy, K. , & Rajendran, N. (2005). Mangrove ecosystems of the Indian Ocean region. https://www.researchgate.net/publication/254434289_Mangrove_ecosystems_of_the_Indian_Ocean_region

149 Bosire J. O. , Mangora M. M. , Bandeira S. , Rajkaran A. , Ratsimbazafy R. , Appadoo C. , Kairo J. G. (2015). Mangroves of the Western Indian Ocean: Status and Management. WIOMSA, Zanzibar pp. (161).

150 Sivakumar K. , Rilwan A. , Priyanka K. , Salah M. , & Kathiresan K. (2018). Mangroves of the atolls of the Maldives, rich among the atoll groups of the Indian Ocean. ISME/GLOMIS Electronic Journal. 16, 3

151 Kathiresan, K. & Rajendran, N. (2005). Mangrove ecosystems in the Indian Ocean region. Indian Journal of Marine Sciences, 34, 1, 104-113

152 Jagtap, T. (1999). Atoll mangroves and associated flora from Republic of Maldives, Indian Ocean. AGRIS: International Information System for the Agricultural Science and Technology. https://agris. fao.org/agris-search/search. do?recordID=AV20120134435

153 Savemaldives. (2022). #savemaldives - Discovery of critically endangered B. hainesii and mass mangrove die-off in the Maldives. https://savemaldives. net/mangrove-die-off-maldives/

154 ibid.

155 Jagtap, T.G., & Untawale, A.G. (1999). Atoll mangroves and associated flora from Republic of Maldives, Indian Ocean. https://drs.nio.org/drs/handle/2264/1837

156 FAO (2020). Global Forest Resources Assessment (2020). Report Maldives. https://www.fao.org/3/cb0027en/cb0027en. pdf

157 Government of Maldives. (2023). Maldives: Accelerating Sustainable System Development Using Renewable Energy Project. https://www.adb.org/sites/default/files/project-documents/55191/55191-001-iee-en_15. pdf

There are four key threats to mangrove permanence in the Maldives: low species diversity in individual stands, unsustainable development, genetic poverty, and drought-induced die-off.

There are four key threats to mangrove permanence in the Maldives: low species diversity in individual stands, unsustainable development, genetic poverty, and drought-induced die-off.

Low species diversity in individual forest stands increases the risk of permanent mangrove loss. While national mangrove diversity is high in the Maldives, the species distribution is patchy and almost monospecific at the stand level. Presently, detailed information on mangrove zonation patterns in the Maldives is lacking. However, isolated studies suggest that in the northern islands, specifically in the Shaviyani and Haa Dhaalu atolls, mangroves tend to form uniform clusters of one or two species, primarily occupying basins or shallow depressions.[158] Monospecific stands and minimal overlapping of species turn the mangroves of the Maldives into highly vulnerable ecosystems and complicate their conservation.

Unsustainable development, including examples from harbor construction, channel building, seawall development, and tourism infrastructure, threaten the Maldives' mangroves. It is estimated that 202 artificial harbors have been constructed and over 10 km2 of lagoon and reef area have been modified for land reclamation purposes in about 15 years alone.[159] An example of reclamation affecting mangroves includes the destruction of the lagoon and the removal of mangroves to build an airstrip in Kulhudhuffushi island (see Figure 18).

Figure 18. Unsustainable development threatens the Maldives' mangroves

Impacts of the airport construction over the mangroves and lagoon in Kulhudhuffushi.

Source: Save Maldives.

158 Jagtap, T.G., & Untawale, A.G. (1999). Atoll mangroves and associated flora from Republic of Maldives, Indian Ocean. https://drs.nio.org/drs/handle/2264/1837

159 Government of Maldives. (2016). https://www.cbd.int/doc/world/mv/mv-nbsap-v2-en.pdf

The high level of specialization of mangroves, their fragmentation, habitat specificity, and discontinuous distribution all affect their genetic diversity.Genetic diversity needs to be considered in any conservation and restoration program.

3. *Genetic poverty:* The high level of specialization of mangroves, their fragmentation, habitat specificity, and discontinuous distribution all affect their genetic diversity. This is particularly relevant in the patchy and highly site-specific mangroves of the Maldives. Genetically similar populations will be similarly affected by disturbances with little opportunity for species survival. Population declines of less genetically diverse mangrove species on the Indo-Malayan coast have been found to be associated with faster sea-level rise.[160] Furthermore, a recent series of flooding events in Yalong Bay, southern China, resulted in the loss of half of the mangrove trees in this area. Importantly, less genetically diverse mangrove species suffered much greater destruction. Genetic diversity needs to be considered in any conservation and restoration program (e.g., diversity of seedling supply). In the Maldives, where genetic diversity is poorer (fewer species in physically isolated islands) and mangroves are far patchier than in the Indo-Malayan region, the risk of population decline after disturbances is much higher.

Mangroves in the Maldives are currently suffering from an extended die-off, whose drivers and future consequences remain poorly understood. "Die-off" is a type of tree mortality that starts with defoliation and results in the standing death of the affected trees.

4. *Mangrove die-off:*[161] Mangroves in the Maldives are currently suffering from an extended die-off (Figure 19 below), whose drivers and future consequences remain poorly understood. "Die-off" is a type of tree mortality that starts with defoliation and results in the standing death of the affected trees. Mangrove die-off began as far back as December 2019 and has currently affected 11 islands from Haa Alif Atoll Uligamu in the far north to Gaaf Dhaal Hoadedhdhoo in the south-central region of the country (see Table 2).[162] Several mangrove sites affected by the die-off host the critically endangered mangrove species Bruguiera hainesii, including Haa Dhaal Kulhudhuffushi, Haa Alif Kelaa, Haa Dhaalu Vaikaradhoo and Noonu, which claims for urgent monitoring and protection. Stakeholders such as the Mangrove Action Project (MAP),[163] Save Maldives, the International Union for Conservation of Nature (IUCN), and the United States Forest Service (USFS) in collaboration with EPA have actively collaborated to map mangrove die-off in the Maldives with support from citizen science and Google Earth Mapping tools. They show that the die-off occurred from North to South and urge for strict protection of the affected sites, so that they can recover. Furthermore, the University of Northumbria (UK) is currently working on mapping changes in the health of Maldivian mangroves from 2015 to 2022, including die-off in Feydhoo island (southernmost distribution of the Maldives) (see Figure 20).

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160 Guo, Z. , Li, X. , He, Z. , Yang, Y. , Wang, W. , Zhong, C. , Greenberg, A. J. , Wu, C. Y. , Duke, N. C. , & Shi, S. (2017). Extremely low genetic diversity across mangrove taxa reflects past sea level changes and hints at poor future responses. Global Change Biology, 24(4), 1741–1748. https://doi.org/10. 1111/gcb. 13968

161 Checinternational.org. (2020). Maldives Mangrove Project Report. https://www.checinternational.org/wp-content/uploads/2020/10/Maldives-Mangrove-Project-Report.pdf

162 Savemaldives. (2022). #savemaldives - Discovery of critically endangered B. hainesii and mass mangrove die-off in the Maldives. https://savemaldives. net/mangrove-die-off-maldives/

163 Savemaldives. (2020). Initial engagement to assess mangrove die-off at Haa Dhaal Neykurendhoo (Sep 2020) . https://savemaldives. net/publications/

Figure 19. Mangroves suffer from die-off in 11 Maldivian islands

Mangrove dieoff in Neykurendhoo Island in June 2020.

Source: Save Maldives. Save Maldives NGO

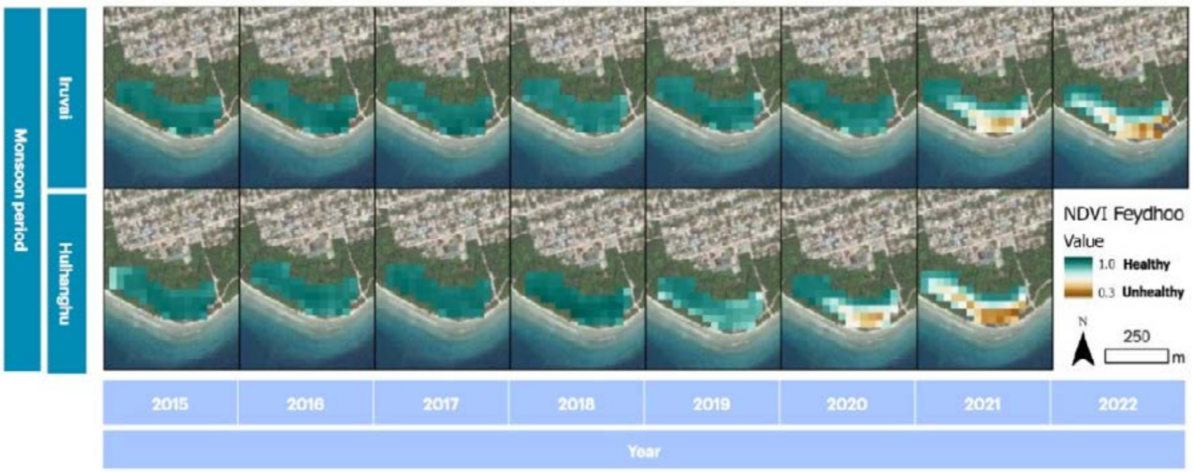
Table 2. List of islands where mangrove die-off has been reported since December 2019

#	Atoll	Island	Protected Status / Date	Baseline Study / Management Plan / Other
1	Haa Alif	Uligamu	Not protected	None
2	Haa Alif	Kelaa	Protected 16 June 2019	Not known
3	Haa Dhaal	Neykurendhoo	Protected 30 December 2018	– Baseline Study by Bluepeace Maldives (1) – No Management Plan
4	Haa Dhaal	Kulhudhuffushi	Not protected + at risk of further'reclamation'	None MAP Report (2)
5	Haa Dhaal	Vaikaradhoo	Not protected	None
6	Haa Dhaal	Nolhivaram	Not protected	None
7	Shaviyani	Feydhoo	Not protected	None
8	Shaviyani	Goidhoo	Not protected	None
9	Shaviyani	Farukolhu	Protected 7 October 2018	Not known
10	Noonu	Kendhikulhudhoo	Protected 16 June 2019	Not known
11	Gaaf Dhaal	Hoadehdhoo	Not protected	Not known

Source: http://www.bluepeacemaldives.org/mangroves/islands/neykurendhoo/, https://savemaldives.net.

Figure 20. Synchronous die-off monitoring relies on trends in vegetation responses such as the NDVI index.

NDVI analysis for monsoon seasons 2015-2022 in the Feydhoo island, the southernmost atoll in the Maldives.



Source: Lucy Carruthers, University of Northumbria.

The synchronous mangrove die-off in the Maldives followed an extended dry period with less-than-normal rainfall (2014-2019).

The synchronous mangrove die-off in the Maldives followed an extended dry period with less-than-normal rainfall (2014-2019). Severe drought has long been suggested to be a driver of mangrove die-off. The Maldives suffered from drought in the central and southern regions from April to December in 2019 with an intensity that ranged from moderate to very intense.[164] August 2019 saw a below -2.5 anomaly for the Standardized Precipitation Index (SPI)[165] and -1.25 anomaly in September 2019. Extreme drought conditions weaken trees and result in defoliation that can lead to the death of vulnerable trees and stands, as well as promoting fungal diseases[166] and insect infestation. Mangrove die-off is more extensively studied in Australia where mortality was reported in the Gulf of Carpentaria[167] and the Mangrove Bay.[168] While mangrove die-off is a complex phenomenon influenced by various factors like inter-tidal variation, prolonged ocean retreat, geomorphological positioning, and soil fertilization, consensus suggests that soil hyper salinization and water stress, often associated with El Niño Southern Oscillation (ENSO)-related drought conditions, are the key drivers. These drought-related mortalities can be compounded by the prior health and growth conditions of the affected stands. For instance, fast growth in young mangroves facilitated by water eutrophication can promote trees that are less resistant to drought, as

164 FECT. (n.d.). Drought and Climate Monitoring for Maldives. https://tropicalclimate.org/Maldives/drought/

165 Yin et al. (2022). https://www.mdpi.com/2073-4433/13/10/1673

166 MEE. (2016). State of Environment. https://www.environment.gov.mv/v2/wp-content/files/publications/20170202-pub-soe-2016.pdf

167 Duke, N. C., Kovacs, J. M., Griffiths, A. J., Preece, L., Hill, D. J. E., Van Oosterzee, P., Mackenzie, J., Morning, H. S., & Burrows, D. (2017). Large-scale dieback of mangroves in Australia. Marine and Freshwater Research, 68(10), 1816. https://doi.org/10. 1071/mf16322

168 Lovelock, C. E., Feller, I. C., Reef, R., Hickey, S., & Ball, M. C. (2017). Mangrove dieback during fluctuating sea levels. Scientific Reports, 7(1). https://doi.org/10. 1038/s41598-017-01927-6

Mangroves provide coastal protection against sea-level rise by trapping sediment and controlling coastal erosion, and they also mitigate the impacts of waves and storm surges.

Mangrove forests in the Maldives also play a pivotal role as nursery habitats for numerous species of commercially valuable coral reef fish.

observed in Panama's die-off. Insect infestation was also present in Panama's die-off as a result of weakened trees.

Even though mangroves in the Maldives are often found in small patches, they provide a range of societal benefits which makes their conservation essential.[169] They provide coastal protection against sea-level rise by trapping sediment and controlling coastal erosion, and they also mitigate the impacts of waves and storm surges.[170] Factors like bottom friction, forest width, tree density, and shape contribute to these coastal protection benefits, with mangroves capable of reducing up to 66% of wave energy within the first 100 m of forest width.[171] Additionally, under appropriate conditions, mangroves can keep pace with sea-level rise through vertical accretion. In the context of the Maldives, mangroves were reported to have buffered the impact of the 2004 Indian Ocean tsunami locally, particularly on Kendhikulhudhoo island in the Noonu Atoll, where mangroves absorbed much of the tsunami's impact, thereby preventing destruction of property and loss of human lives.[172]

Maldivian mangroves also contribute to groundwater storage. Mangrove soils are key areas to promote infiltration and increase groundwater storage. These soils serve as filters, capturing and absorbing nutrients from sewage and runoff, and sequestering heavy metals, thus aiding in maintaining water quality.[173] Furthermore, soil humus in mangrove areas acts as a sponge, helping regulate water balances.[174]

In addition to their other roles, mangroves also mitigate flooding during the rainy season. The highly permeable soils within mangrove forests make them effective flood buffers.[175] Given that mangroves and adjacent water bodies often lie at the lowest elevations on many islands, they serve as critical catchment and storage zones for rainwater runoff.

Mangrove forests in the Maldives also play a pivotal role as nursery habitats for numerous species of commercially valuable coral reef fish.[176] These young fish, in their larval and juvenile stages, seek refuge from predators and harsh

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169 Curnick, D. J. , Pettorelli, N. , Amir, A. N. , Balke, T. , Barbier, E. B. , Crooks, S. , Dahdouh-Guebas, F. , Duncan, C. , Endsor, C. , Friess, D. A., Quarto, A. , Zimmer, M. , & Lee, S. Y. (2019). The value of small mangrove patches. Science, 363(6424), 239. https://doi.org/10. 1126/science. aaw0809

170 Menéndez, P. , Losada, I. J. , Torres-Ortega, S. , Narayan, S. , & Beck, M. (2020). The Global Flood Protection Benefits of Mangroves. Scientific Reports, 10(1). https://doi.org/10. 1038/s41598-020-61136-6

171 ibid

172 Blue Peace Maldives (n.d.). Mangroves that saved Kendhikulhudhoo from tsunami under threat now. http://www.bluepeacemaldives.org/blog/biodiversity/kendhikulhudhoo-mangroves-under-threat

173 Tam, N. F. , & Wong, Y. J. (1996). Retention and distribution of heavy metals in mangrove soils receiving wastewater. Environmental Pollution, 94(3), 283–291. https://doi.org/10. 1016/s0269-7491(96)00115-7

174 Holliday et al. (2007). Geological controls and tidal forcing of submarine groundwater discharge from a confined aquifer in a coastal sand dune system. Journal of Geophysical Research (Oceans) 112.

175 Deb, M. & Ferreira, C. M. (2017) Potential impacts of the Sunderban mangrove degradation on future coastal flooding in Bangladesh. Journal of Hydro-Environment Research, 17, 30–46

176 Dorenbosch, M., et al. (2005). Indo-Pacific seagrass beds and mangroves contribute to fish density coral and diversity on adjacent reefs. Marine Ecology Progress Ecology, 63-76

Mangroves are very efficient in soaking up carbon dioxide from the atmosphere and storing it in their biomass and soils.

physical conditions within the mangrove forests that maintain a hydrological connection to their adult reef habitats. Thus, preserving these forests and their connectivity to reefs contributes significantly to the sustainability of the Maldivian fisheries sector.

In addition to their ecological roles, mangroves and other wetlands in the Maldives offer a variety of cultural benefits, encompassing recreational, educational, spiritual, and religious aspects. For instance, during the celebration of Eid, locals on Kulhudhuffushi island partake in the tradition of covering themselves with mangrove mud. Furthermore, mangroves in the same area support the time-honored practice of coconut husk coir rope making by preserving the waterbody where coconut husks are soaked in preparation for rope production. Some northern islands with wetlands, such as N. Kendhikulhudhoo and HA. Thakandhoo, turn to milkfish cultivation during periods of low tuna fish catches. Once the milkfish mature, they are communally harvested and distributed among the community members, symbolizing unity and shared resources.

Globally, mangroves also have an important role in mitigating climate change, as they grow fast and store large amounts of carbon in the sediments. Mangroves are very efficient in soaking up carbon dioxide from the atmosphere and storing it in their biomass and soils. Other countries with similar small and patchy mangroves have shown that these habitats can contribute substantially to national targets for climate change mitigation. Under inundated conditions, organic matter buried in the sediment decomposes slowly and accumulates over long periods, with carbon radio-isotopic studies indicating millennia-long accumulation. Consequently, the soils of mangrove ecosystems are exceptionally valuable carbon deposits, reaching up to 1000 tons of carbon storage per hectare (Mg C ha-1.),[177] compared to the standing trees and aboveground biomass values which reach up to 200 Mg C ha-1. When compared with other tropical forests (upland rainforests), mangrove soils store more than 2 times the total carbon biomass stored in tropical rainforests, and almost 5 times more when only aboveground biomass is compared (see Figure 21 below for mangroves vs other vegetation types in Micronesia). This disproportionate amount of soil carbon is a general pattern in mangrove ecosystems; a global study178 with 190 world-wide sample sites showed that, on average, the mean aboveground C stock was 230 ± 14 Mg C ha-1 and the mean belowground C stock was 3 times: 741 ± 30 Mg C ha-1 (1m soil depth). Degradation of mangroves can cause the sediments to release CO_2 and other Greenhouse gases (GHG) into the atmosphere, making them and other coastal wetlands targets of climate mitigation programs that aim at avoiding the degradation of the carbon stocks stored in their sediments, as well as promoting new biomass growth.[179]

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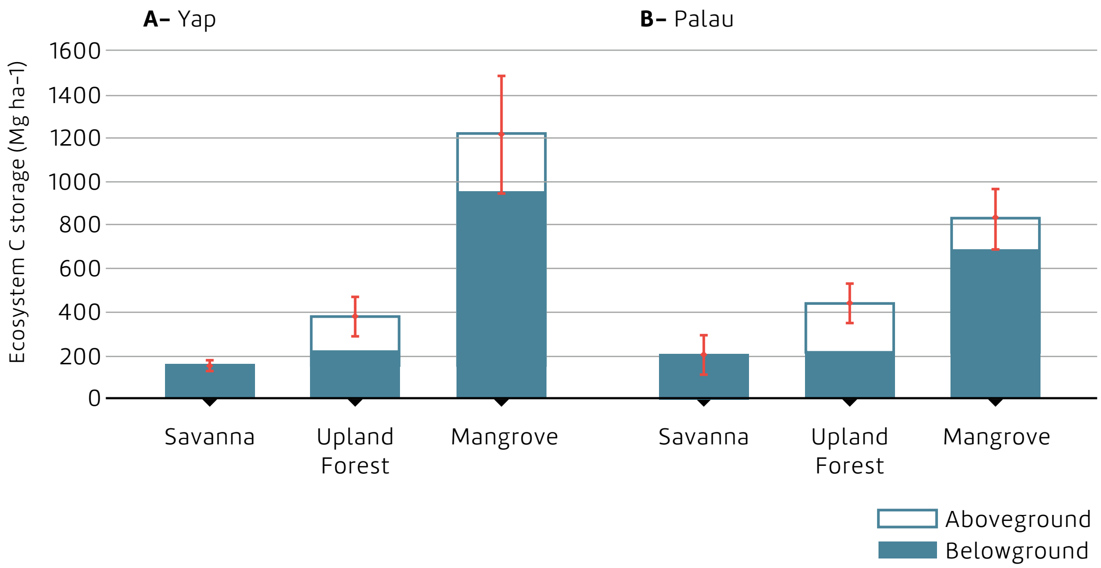
177 Donato et al. (2012) https://www.fs.usda.gov/psw/publications/donato/psw_2012_donato001.pdf

178 Kauffman, J. B. , Adame, M. F. , Arifanti, V. B. , Schile, L. M. , Bernardino, A. F. , Bhomia, R. K. , Donato, D. C. , Feller, I. C. , Ferreira, T. M. , Del Carmen Jesus Garcia, M. , MacKenzie, R. A. , Megonigal, J. P. , Murdiyarso, D. , Simpson, L. T. , & Trejo, H. E. (2020). Total ecosystem carbon stocks of mangroves across broad global environmental and physical gradients. Ecological Monographs, 90(2). https://doi.org/10. 1002/ecm. 1405

179 The red lines extending from the tops of the bars indicate the 95% confidence intervals, which reflect the variability or uncertainty of the mean estimates, thereby highlighting the probable range of the true means

Figure 21. Mangrove forests store large amounts of carbon.

Ecosystem C storage (mean, 95% CI in Mg C ha-1) in the three major vegetation types of Yap and Palau in Micronesia.[179]



Source: Donato et al. (2012)

The ecosystem service benefits provided by Maldivian mangroves remain undervalued and mangroves lack legal protection.

The ecosystem service benefits provided by Maldivian mangroves remain undervalued and lack legal protection. Mangroves (and other wetlands) are also absent in most international agreements to which the Maldives is a signatory party. As an example, the Maldives' submissions to the UN-Climate Convention (e.g., the National Communication and the country's NDC)[180] excluded the land use sector (e.g., forests, wetlands).[181] In contrast, other countries in the region, like the Seychelles, are including NbS in their NDCs that aim at protecting coastal and marine ecosystems for adaptation and blue carbon for mitigation (Box 4).[182] In response to the lack of awareness of the importance of mangrove conservation, local and regional organizations have been raising awareness of this issue since 2008. Some initiatives include Save the Maldives, the National Mangrove Management Program,[183] Conserving Mangroves through the Development of an Informative Website and Community Advocacy,184 and the #GreenTurtlesGaadhoo social media campaign.

180 MoECCT (2020). Update of Nationally Determined Contribution of Maldives. https://unfccc. int/sites/default/files/NDC/2022-06/Maldives%20Nationally%20Determined%20Contribution%202020. pdf

181 ibid.

182 Republic of Seychelles. (2021). Seychelles' Updated Nationally Determined Contribution. Submission under the Paris Agreement, July 2021. https://unfccc. int/sites/default/files/NDC/2022-06/Seychelles%20-%20NDC_Jul30th%202021%20_Final. pdf

183 Mangroves for the Future (n.d.). Maldives - Investing in coastal ecosystems. http://www.mangrovesforthefuture.org/countries/members/maldives/

184 Blue Peace Maldives (n.d.). Conserving Mangroves through the Development of an Informative Website and Community Advocacy. http://www.bluepeacemaldives.org/mangroves/about/

In response to the lack of awareness of the importance of mangrove conservation, local and regional organizations have been raising awareness of this issue since 2008.

2.1.3 Seagrasses

Box 4. Seychelles commitments for coastal wetlands under their NDCs

- Seychelles intends for coastal planning and infrastructure to be regulated at the national and local level to prioritize the consideration of "blue" Nature-based Solutions (NbS) for climate resilience.
- Seychelles will protect its blue carbon ecosystems, i.e., at least 50 percent of its seagrass and mangrove ecosystems by 2025, and 100 percent of seagrass and mangrove ecosystems by 2030;
- Seychelles will establish a long-term monitoring program for seagrass and mangrove ecosystems by 2025 and include the GHG sink of Seychelles' blue carbon ecosystems within the National Greenhouse Gas Inventory by 2025;
- Seychelles commits to the implementation of its adopted Marine Spatial Plan and the effective management of the 30 percent marine protected areas within the Seychelles' Exclusive Economic Zone.

Seagrass ecosystems are understudied in the Maldives. There is currently no national map of seagrasses, and seagrass habitats in deep-sea beds remain unmapped and understudied throughout the entire Indian Ocean region.[185] A handful of initiatives have conducted some work on habitat classification, assessment, and mapping, such as the REGENERATE Project[186] (2013-2019). This project provided natural capital valuations for three atolls (Aduu, Baa, and North Ari Atolls) including for seagrasses,[187,188,189] but did not create any comprehensive seagrass maps. The Allen Coral Atlas[190] maps several benthic cover types in the Indian Ocean but suffers from a large underestimation of seagrass meadows. The Allen Coral Atlas map estimates a total seagrass cover of only 46.6 km^2 (4,663 hectares) for the Central Indian Ocean. However, current estimates of seagrass extent for the Seychelles alone reach 20,000 km^2.[191] Typically, countries use satellite imagery to map seagrass in shallow

185 Esteban, N. , Unsworth, R. K. F. , Gourlay, J. , & Hays, G. C. (2018). The discovery of deep-water seagrass meadows in a pristine Indian Ocean wilderness revealed by tracking green turtles. Marine Pollution Bulletin, 134, 99–105. https://doi.org/10. 1016/j. marpolbul. 2018. 03. 018

186 International Union for Conservation of Nature. (n.d.). Ecosystem Services Assessment of North Ari Atoll. USAID. https://portals. iucn.org/library/sites/library/files/documents/2017-003_0. pdf

187 Emerton et al. (2009). https://portals.iucn.org/library/sites/library/files/documents/2017-003_0.pdf

188 Agardy, T. , Hicks, F. , Nistharan, F. , & Grimsditch, G. (2017). Ecosystem Services Assessment of North Ari Atoll Maldives. ResearchGate. https://www.researchgate. net/publication/313368538_Ecosystem_Services_Assessment_of_North_Ari_Atoll_Maldives

189 Kenchington, R. , Naeem, H. , Abdulla, S. , & Neller, R. (2009). Framework for an Ecosystem-based Management Plan Addu Atoll, Republic of Maldives. ResearchGate. https://www.researchgate. net/publication/305985433_Framework_for_an_Ecosystem-based_Management_Plan_Addu_Atoll_Republic_of_Maldives

190 Allen Coral Atlas. (n.d.). Dive into the Atlas. https://allencoralatlas.org/

191 Elizabethalberts. (2022, April 22). To get people thinking about seagrass, Seychelles coins new Creole words. Mongabay EnvironmentalNews.https://news.mongabay.com/2022/04/to-get-people-thinking-about-seagrass-seychelles-coins-new-creole-words/#:~:text=Seychelles%20has%20an%20estimated%2020%2C000,development%20and%20other%20human%20activities.

Seagrass ecosystems are understudied in the Maldives. There is currently no national map of seagrasses, and seagrass habitats in deep-sea beds remain unmapped and understudied throughout the entire Indian Ocean region.

clear waters. However, extensive fieldwork is necessary to train the algorithms and verify the accuracy of the classified areas, ensuring they are indeed seagrass and not other ecosystems that might appear similar on satellite imagery, such as algae, seaweed, and kelp.

Photo Description: Fisherman standing in seagrass © Benjamin L.Jones/Unsplash

There are several regional initiatives on seagrass mapping. The University of Northumbria leads a project on seagrass mapping in the Maldives (Box 5). Furthermore, standardized seagrass habitat mapping is conducted throughout the Indian Ocean by The Pew Charitable Trust,[192] who also helped the Seychelles to produce its first seagrass maps in September 2022 (in collaboration with Oxford University, The German Space Agency, and the University of Seychelles). A Roadmap to Blue Carbon opportunities was developed in 2022 for the Seychelles under the James Michel Foundation[193] in partnership with Deakin University in Australia and Seychelles' Ministry of Agriculture, Climate Change and Environment and identifies potential Blue Carbon opportunities in which seagrasses are featured.

Seagrasses, often mistaken for algae, are specialized flowering plants that inhabit underwater environments and can tolerate brief exposures to air during intertidal periods. Seagrasses live in connection to coral reefs and mangroves, whose health and stability remain mutually entangled. While they are common in shallow waters, with sufficient water clarity such as in the Maldives they grow up to a depth of 70 meters. Because seagrasses respond well to the phosphorus content in sediments (but not in the water column that promotes shadowing due to algae blooming), they are more abundant near traditional fishing villages where fishing byproducts are discarded into the water.[194]

192 Trusts, P. C. (2021). Project Will Map Seagrass in Seychelles to Support Climate Action. The Pew Charitable Trusts. https://www.pewtrusts.org/en/research-and-analysis/fact-sheets/2021/01/project-will-map-seagrass-in-seychelles-to-support-climate-action

193 The Seychelles Conservation and Climate Adaptation Trust. (n.d.). Roadmap to Blue Carbon opportunities in the Seychelles. https://seyccat.org/roadmap-to-blue-carbon-opportunities-in-the-seychelles/

194 Personal communication with Ahmed Shakeel (Oceanographic Society of Maldives)

Box 5. Seagrass mapping in the Maldives

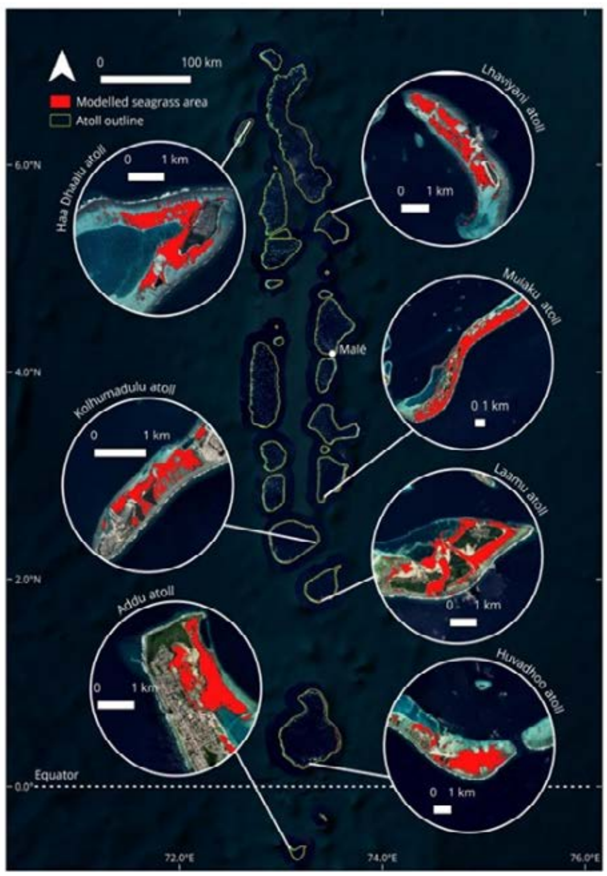
The University of Northumbria is researching seagrass meadow mapping in the Maldives using remote sensing under the Google Earth Engine platform. Figure 20 shows an advance of their work (led by Dr. Holly East and implemented by Matthew Floyd). The map was created using 881 Sentinel-2 images of the Maldives in the year 2021, from which 25,463 training pixels and 993 validation pixels were obtained. Based on this map, the total area of shallow seagrass meadows in the Maldives reaches about 110 km2 (11,000 hectares) with an 88.5 percent of overall accuracy (data in press).

The map is currently with the Waitt Foundation to enable the incorporation of seagrasses in the Noo Raajje work, hoping that they will be considered in the design of the nation's new network of Marine Protected Areas.

This project currently only covers shallow meadows because deeper meadows are not captured by satellite data. Research in the Great Chagos Bank suggests deep-water seagrass may be more abundant than previously assumed. Future work may aim for off-shore deep-sea seagrass mapping and monitoring in the Maldives, which will help quantify changes in the extent of seagrass meadows.

Figure 22. The total area of shallow seagrass meadows in the Maldives amounts to 110 km^2

Ecosystem C storage (mean, 95% CI in Mg C ha–1) in the three major vegetation types of Yap and Palau in Micronesia.



Source: Northumbria University (Matthew Floyd).

Seagrasses live in connection to coral reefs and mangroves, whose health and stability remain mutually entangled.

Current official reports seem to underestimate the biodiversity of seagrass species in the Maldives. From the 24 seagrass species in the tropical Indo-Pacific (72 species worldwide),[195] the Western Indian Ocean hosts 13 reported seagrass species, covering wide areas of near-shore soft bottoms through its 12,000 km of coastline.196 The greatest diversity of seagrass species is located along Mozambique, Tanzania and Kenya's coastlines, and decreases eastwards towards the islands of Central Indian Ocean.[197] In the Maldives, previous research identified five species of seagrasses under four genera.[198,199] However, the Maldives Seagrass Monitoring Network (2020) reports eight seagrass species and records in the citizen science App: Seagrass Spotter[200] (last visited December 2022) reported nine species. While further validation is needed to test the floristic accuracy of the spotted species, the Seagrass Spotter shows that the number of seagrass species is underestimated in official reports.

Coastal development damages seagrasses in the Maldives, with practices such as land reclamation, chemical pollution, and manual removal by resort operators causing extensive damage.

Coastal development damages seagrasses in the Maldives, with practices such as land reclamation, chemical pollution, and manual removal by resort operators causing extensive damage. Sedimentation from land reclamation and nutrients from agricultural fertilizers and untreated sewage contribute to light stress. When this stress is coupled with factors like ocean warming, pathogens, or storms, it can lead to seagrass die-off, particularly in highly populated coastal areas with intense human activity.[201] Some resorts actively remove the seagrass meadows surrounding their resort islands. This is done by either smothering seagrass meadows with plastic tarp or sand to block out sunlight, or actively plucking it out of the seabed.[202] Water eutrophication, a process where excessive nutrients lead to dense growth of plant life and death of animal life from lack of oxygen, is another threat to seagrass beds, and is often exacerbated by improper wastewater disposal.[203]

Seagrass ecosystems are important feeding grounds for marine fish and crustacean species of economic importance such as shrimps (Penaeus) and

195 Pirog, R. S. (n.d.). Seagrass ecology and threats in the tropical Indo-Pacific bioregion. https://researchonline. jcu. edu. au/15703/

196 Dhunya, A. , Huang, Q. , & Aslam, A. (2017). Coastal Habitats of Maldives: Status, Trends, Threats, and potential conservation Strategies. International Journal of Scientific & Engineering Research, Volume 8, (3). https://www.ijser.org/researchpaper/Coastal-Habitats-of-Maldives-Status-Trends-Threats-and-potential-conservation-Strategies. pd

197 Payri, C. , De Ramon N'Yeurt, A. , & Mattio, L. (2012). Benthic algal and seagrass communities in Baa Atoll, Maldives. ResearchGate. https://www.researchgate. net/publication/236965629_Benthic_algal_and_seagrass_communities_in_Baa_Atoll_Maldives

198 MHAHE. (2002). "First National Report of the Maldives to the Convention on Biological Diversity. Male': Ministry of Home Affairs, Housing and Environment"

199 Dhunya, A. , Huang, Q. , & Aslam, A. (2017). Coastal Habitats of Maldives: Status, Trends, Threats, and potential conservation Strategies. International Journal of Scientific & Engineering Research, Volume 8, Issue 3. . https://www.ijser.org/researchpaper/Coastal-Habitats-of-Maldives-Status-Trends-Threats-and-potential-conservation-Strategies. pdf

200 SeagrassSpotter. (n.d.). https://seagrassspotter.org/explore

201 Klohmann, C. A. , & Padilla-Gamiño, J. L. (2022). Pathogen Filtration: An Untapped Ecosystem Service. Frontiers in Marine Science, 9. https://doi.org/10. 3389/fmars. 2022. 921451

202 Evans, C. (2019). Maldives Seagrass: What You Need to Know. - PADI Blog - Latest Scuba Diving News, Events, Blogs, Articles & More. https://blog. padi.com/maldives-seagrass-what you need to know /#:~:text=However%2C%20one%20clear%20threat%20to,meadows%20surrounding%20their%20resort%20islands.

203 Miller, M. K. , & Sluka, R. D. (1999). Patterns of Seagrass and Sediment Nutrient Distribution Suggest Anthropogenic Enrichment in Laamu Atoll, Republic of Maldives. Marine Pollution Bulletin, 38(12), 1152–1156. https://doi.org/10. 1016/s0025-326x(99)00147-2

Seagrass beds stabilize bottom sediments and serve as effective barriers against wave energy and current velocity.

spiny lobster (Panulirus).[204] Seagrass beds also support sizeable populations of several endangered species that feed on them: the Maldives' Red list (critically) endangered Hawksbill and Green Turtles (Eretmochelys imbricata and Chelonia mydas), and the endangered or vulnerable Manta Rays: Ornate Eagle Ray (Aetomylaeus vespertilio) and Oceanic Manta Ray (Mobula alfredi).

Photo Description: Swift Footed Rock Crab, Baa Atoll, Maldives © World Bank

Seagrasses have also been found to have desirable biomedical properties, to prevent disease outbreaks through their pathogen filtration capacity, and have significant soil carbon storage potential.

Seagrass beds stabilize bottom sediments and serve as effective barriers against wave energy and current velocity.[205,206,207] Seagrass meadows have been found to reduce wave heights up to 70 percent and promote the deposition of suspended sediments. Seagrasses have also been found to reduce near-bottom wave velocities by up to 90 percent. By reducing wave energy, seagrasses help reduce coastal erosion.

Seagrass ecosystems provide many other benefits to the Maldivian people and

204 Ochieng, C. A. , & Erftemeijer, P. (1993). The Seagrasses of Kenya and Tanzania. ResearchGate. https://www.researchgate. net/publication/305402549_The_Seagrasses_of_%20Kenya_and_Tanzania

205 VLIZ (n.d.). Marine World Heritage – Feature 4c-Seagrasses. https://www.vliz. be/projects/marineworldheritage/Features/feature4c. php?item=The%20Indian%20Ocean

206 Chen, W. , Muller, P. O. , Grabowski, R. C. , & Dodd, N. (2022). Green Nourishment: An Innovative Nature-Based Solution for Coastal Erosion. Frontiers in Marine Science, 8. https://doi.org/10. 3389/fmars. 2021. 814589

207 Hansen, J. K. , & Reidenbach, M. A. (2012). Wave and tidally driven flows in eelgrass beds and their effect on sediment suspension. Marine Ecology Progress Series, 448, 271–287. https://doi.org/10. 3354/meps09225

Conservationists in the Maldives launched a campaign in 2019 to help bring the spotlight to the rich biodiversity of seagrasses.

economy. These ecosystems underpin many coastal traditional ways of life in the Indo-Pacific offering food, recreation and spiritual fulfillment.[208] As critical components of Indo-Pacific tropical marine environments, they provide some of the most economically important ecosystem services of any marine habitat. These ecosystem services include habitat stabilization, contributions to water quality, and nutrient cycling.[209] Seagrass ecosystems also support fisheries due to their role as nurseries and breeding grounds.[210] Furthermore, seagrasses have also been found to have desirable biomedical properties,[211] to prevent disease outbreaks through their pathogen filtration capacity,[212] and have significant soil carbon storage potential (see Section 3.3).[213] Through these ecosystem services, seagrasses contribute substantially to the Blue Economy of the Maldives.

Conservationists in the Maldives launched a campaign in 2019 to help bring the spotlight to the rich biodiversity of seagrasses. Funded by the Six Senses Laamu and the Blue Marine Foundation, the #ProtectMaldivesSeagrass campaign[214] aimed to raise awareness about the benefits and biodiversity and ecological importance of seagrass meadows in the Maldives amongst private tourist resorts and local communities. Now 37 resorts have pledged to protect over 1 km^2 of the ecosystem throughout the country, in collaboration with a wide range of international and local partners.[215] The #ProtectMaldivesSeagrass campaign was launched on the World Seagrass Day in 2019 and ran for three months. While the campaign is officially over, the work among the network of partners is ongoing. Education around seagrass forms an integral part of the Blue Marine Foundation's Resilient Reefs Project. The team continues to educate local communities, youth and government officials about the importance of seagrass to ensure that these areas are conserved and has connected thousands of divers with the Seagrass Spotter App,[216] which works as a useful citizen science space that partly covers this important ecological research gap.

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208 Unsworth, R. K. , Coles, R. , Grech, A. , & Short, F. T. (2011). Seagrass ecology and threats in the tropical Indo-Pacific bioregion. ResearchGate. https://www.researchgate. net/publication/271645585_Seagrass_ecology_and_threats_in_the_tropical_Indo-Pacific_bioregion

209 Coles et al. (2011). Seagrass ecology and threats in the tropical Indo-Pacific bioregion. In: Pirog, Robert S., (ed.). Seagrass: Ecology Uses and Threats. Oceanography and Ocean Engineering. Nova Science Publishers, New York, NY, USA, pp. 225-239.

210 Jiang, Z. , Huang, D. , Fang, Y. , Cui, L. , Zhao, C. , Liu, S. , Wu, Y. , Chen, Q. , Ranvilage, C. I. P. M. , He, J. , & Huang, X. (2020). Home for Marine Species: Seagrass Leaves as Vital Spawning Grounds and Food Source. Frontiers in Marine Science, 7. https://doi.org/10. 3389/fmars. 2020. 00194

211 Gono, C. M. P. , Ahmadi, P. , Hertiani, T. , Septiana, E. , Putra, M. Y. , & Chianese, G. (2022). A Comprehensive Update on the Bioactive Compounds from Seagrasses. Marine Drugs, 20(7), 406. https://doi.org/10. 3390/md20070406

212 Klohmann and Padilla-Gamino. (2022). https://www.frontiersin.org/articles/10.3389/fmars.2022.921451/full

213 UNESCO (n.d.). Assessing potential World Heritage marine sites in the Western Indian Ocean. https://www.vliz.be/projects/marineworldheritage/Features/feature4c.php?item=The%20Indian%20Ocean

214 Bm-Admin. (2021). #ProtectMaldivesSeagrass campaign. Blue Marine Foundation. https://www.bluemarinefoundation.com/2019/03/04/protectmaldivesseagrass/

215 Welle, D. (2021, November 2). Saving the Maldives' overlooked seagrass meadows. dw.com. https://www.dw.com/en/saving-precious-seagrass-meadows-in-the-maldives/a-59682874

216 SeagrassSpotter. (n.d.). Explore > Grid - Seagrass Spotter. https://seagrassspotter.org/explore

Macroalgae monitoring is part of the National Coral Reef Monitoring Program. However, as of April 2023, no maps exist on hotspots of algae diversity in the Maldives, nor their diversity, their health status nor their population trends.

2.1.4 Algae

Figure 23. Some microalgae species (phytoplankton) can be spotted along the shores at night in the Maldives

Phytoplankton (microalgae) in the Maldives in 2010.

Source: Doug Perrine (www.kuoni.co.uk).

Marine algae can be divided into microalgae (also known as phytoplankton) and macroalgae (some macroalgae are seaweeds). Unlike seagrasses, which are vascular plants with flowers, algae are not vascular and do not always reproduce sexually. Macroalgae are well known for their commercial interest (kelp and seaweed farms) Microalgae are far less studied in spite of the popularity of some species due to their bioluminescent properties (see Figure 23). Macroalgae monitoring is part of the National Coral Reef Monitoring Program. However, as of April 2023, no maps exist on hotspots of algae diversity in the Maldives, nor their diversity, their health status nor their population trends.

In the Maldives, calcifying algae like Halimeda or Acetabularia contribute to the sediment production of atolls, although coral sands are the primary supply to long-term island stability

The Maldives is considered a "cold spot"[217] for benthic[218] macroalgae due to its relatively low diversity, with only 321 species identified so far. However, this might be a result of inadequate research. In 2009 a marine survey in Baa Atoll[219] provided the first census of marine flora (macroalgae and seagrasses) and reported 176 algae species, of which 113 were recorded for the first time in the Maldives. The most updated compilation of the marine flora of the Maldives from "algaebase.com"[220] listed 208 benthic algae species in 2022. However, the Baa survey identified an additional 113 species, raising the total to 321, suggesting that the perceived low diversity may be the result of insufficient surveying.

Diversity of macro-algae varies across different habitats within the Maldives. The Indian Ocean hosts 2,894 marine algae species in 66 sites across the [221] but these include more algae types than benthic macroalgae. Lagoon patch reefs and oceanic reef slopes exhibit the greatest diversity of macro-algae in the Maldives, hosting 38 species each on average. Lagoon sites are home to an average of 26 species, while the deep lagoon floor and seagrass beds on ocean-exposed reef flats host fewer species. The most commonly found species across all surveyed sites were Tydemania expeditionis and Halimeda minima (green algae) and the most species rich genera appeared to be Halimeda and Caulerpa.

Large accumulation of Sargassum, a type of brown seaweed that emits a foul-odor when decomposing, hasn't historically been an issue in the Maldives.[222] However, beginning in 2022, blooming events have started to affect some beaches.[223] The reasons behind these recent Sargassum blooms remain unclear, and further research is necessary to determine the amount, frequency, and causes of these events. These Sargassum blooms can have substantial economic implications, as evidenced by their impact on tourism in the Caribbean.

In the Maldives, calcifying algae like Halimeda or Acetabularia contribute to the sediment production of atolls, although coral sands are the primary supply to long-term island stability.[224] Specifically, Halimeda algae make up to a 10

217 Price, A. D. , Vincent, L. P. A. , Venkatachalam, A. J. , Bolton, J. S. , & Basson, P. W. (2006). Concordance between different measures of biodiversity in Indian Ocean macroalgae. Marine Ecology Progress Series, 319, 85–91. https://doi.org/10. 3354/meps319085

218 NOAA (n.d.). Ocean Explorer: Arctic Exploration 2002: Background. https://oceanexplorer. noaa.gov/explorations/02arctic/background/benthos/benthos. html#:~:text=Animals%20that%20live%20on%20the,%2C%20crabs%2C%20and%20many%20more.

219 Payri et al. (2010). Benthic algal and seagrass communities in Baa Atoll, Maldives. https://repository.si.edu/bitstream/handle/10088/18282/00590.02.pdf

220 Kapustin, D. A. , Glushchenko, A. M. , & Kulikovskiy, M. S. (2022). Achnanthidiumbratanense sp. nov. (Bacillariophyceae, Achnanthidiaceae), a new diatom from the Lake Bratan (Bali, Indonesia). PhytoKeys, 188, 167. https://www.ncbi. nlm. nih.gov/pmc/articles/PMC8799627/

221 Price, A. D. , Vincent, L. P. A. , Venkatachalam, A. J. , Bolton, J. S. , & Basson, P. W. (2006). Concordance between different measures of biodiversity in Indian Ocean macroalgae. Marine Ecology Progress Series, 319, 85–91. https://doi.org/10. 3354/meps319085

222 Doty, M. S. (1954). Distribution of the algal genera Rhipilia and Sargassum in the central Pacific. Pacific Science, 8, 367–368.

223 MV+. (n.d.). Seaweed Season in the Maldives – Can Use them for Fertilizers. https://www.plus.mv/news-english/22491/#:~:text=Seaweed%20variety%20called%20Sargassum%20is,makes%20an%20excellent%20natural%20fertilizer.

224 Li, Y. , Zou, X. , Ge, C. , Tan, M. , Tang, M. , Liu, X. , Wang, L. , Liu, Y. , & Wang, X. (2020). Age and sedimentary characteristics of beach sediments from Yongle Atoll, South China Sea: Implications for sediments supply in a coral reef system. Journal of Asian Earth Sciences, 187, 104083. https://doi.org/10. 1016/j. jseaes. 2019. 104083

Algae can provide other valuable ecosystem services. When present in very high densities, Halimeda contributes to climate change mitigation by acting as a strong carbon sink.

percent contribution to gravel-size beach sediments, as observed on Vakkaru island where they contribute approximately 69,000 kilograms per year.[225] While sedimentation rates can be high, research with radio-carbon has shown that in the Maldives Halimeda carbonates do not remain on the shoreline for long due to their smaller grain size, which makes them more vulnerable to erosion and current transportation[226]. Despite the fundamental importance of these ecological-sedimentary links for island development and future maintenance, reef island sediment production and calcification health remain poorly quantified in the Maldives.[227]

Algae can provide other valuable ecosystem services. When present in very high densities, Halimeda contributes to climate change mitigation by acting as a strong carbon sink. Carbonate production rates in the Caribbean and Indian Ocean of Halimeda can be as high as 2 kg $CaCO^3$ m-2 yr-1.[228,229] However, in the Indian Ocean, Halimeda production rates are lower (50-100 g $CaCO^3$ m-2 yr-1).[230] Additionally, algae[231] also have valuable pharmaceutical and biomedical properties, with their extracts being sought after in these fields.[232,233] Lastly, algae contribute to bioremediation, a process that uses living organisms to clean up polluted environments.[234]

Ocean acidification has been identified as a major climate-related threat to marine calcifying algae and other calcifying organisms such as corals.

Ocean acidification (OA) has been identified as a major climate-related threat to marine calcifying algae and other calcifying organisms such as corals.[235] OA impacts on these organisms will cause significant declines in regional and global carbonate production. This is a concern for the Maldives, as coral sands and calcifying algae like Halimeda contribute to sedimentation and shoreline stability,

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225 Perry, C. T. , Kench, P. S. , O'Leary, M. J. , Morgan, K. , & Januchowski-Hartley, F. A. (2015). Linking reef ecology to island building: Parrotfish identified as major producers of island-building sediment in the Maldives. Geology, 43(6), 503–506. https://doi.org/10. 1130/g36623. 1

226 Li, Y. , Zou, X. , Ge, C. , Tan, M. , Tang, M. , Liu, X. , Wang, L. , Liu, Y. , & Wang, X. (2020). Age and sedimentary characteristics of beach sediments from Yongle Atoll, South China Sea: Implications for sediments supply in a coral reef system. Journal of Asian Earth Sciences, 187, 104083. https://doi.org/10. 1016/j. jseaes. 2019. 104083

227 ibid.

228 Freile, Deborah & Hillis, L.. (1997). Carbonate productivity by Halimeda incrassata in a land proximal lagoon, Pico Feo, San Blas, Panama. Proc 8th Int Coral Reef Symp. 1. 767-772.

229 Schubert, Nadine & Alvarez-Filip, Lorenzo & Hofmann, Laurie. (2023). Systematic review and meta-analysis of ocean acidification effects in Halimeda: Implications for algal carbonate production. 4. 100059. 10.1016/j.ecochg.2022.100059.

230 Hudson, J. B. (1985). Growth Rate and Carbonate Production in Halimeda opuntia: Marquesas Keys, Florida. In Springer eBooks (pp. 257–263). https://doi.org/10. 1007/978-3-642-70355-3_20

231 Mateo-Ramírez, Á. , Máñez-Crespo, J. , Royo, L. C. , Tuya, F. , Castejón-Silvo, I. , Hernán, G. , Pereda-Briones, L. , Terrados, J. , & Tomas, F. (2022). A Tropical Macroalga (Halimeda incrassata) Enhances Diversity and Abundance of Epifaunal Assemblages in Mediterranean Seagrass Meadows. Frontiers in Marine Science, 9. https://doi.org/10. 3389/fmars. 2022. 886009

232 Selim (2012). Antimicrobial, Antiplasmid and Cytotoxicity Potentials of Marine Algae Halimeda opuntia and Sarconema filiforme collected from Red Sea Coast. World Academy of Science, Engineering and Technology International Journal of Marine and Environmental Sciences, 6, 1

233 ibid.

234 Rattanasonboom et al. (1983). Nutritive values and heavy metals of the green seaweed Halimeda macroloba Decaisne (Chlorophyta: Halimedaceae) from Phuket. Proceedings of The 5th National Meeting on Biodiversity Management in Thailand.

235 Schubert, N., Alvarez-Filip, L., & Hofmann, L.C. (2023). Systematic review and meta-analysis of ocean acidification effects in Halimeda: Implications for algal carbonate production. Climate Change Ecology, 4, 100059.

The Maldives would highly benefit from establishing a national network to monitor accretion rates, ocean acidification levels, and calcification rates in corals and calcifying algae.

which are critical for the islands' integrity and resistance against sea-level rise.[236] OA causes calcareous organisms to increase porosity, and therefore break more easily when waves impact. As a result, while more sediment can be generated in the short term, overall, calcareous organisms are not growing at a significant rate to cope with OA, SLR or wave force strengthening. OA is also known to interact with bleaching through CO^2 concentrations. Thus, temperature-induced mass coral bleaching causing mortality on global scales started when atmospheric CO^2 exceeded 320ppm CO^2 (Veron et al 2009), and at 340ppm CO^2, a very destructive mass bleaching occurred in most reefs world-wide associated with El Niño events, superposed on far warmer oceans. At today's level of 420ppm CO^2 (in May 2023), with a 10-year lag-time for the sea temperature to respond, most reefs are thought to be committed to an irreversible decline due to enhanced warming and OA. The progressive onset of ocean acidification will cause reduction of coral growth and retardation of the growth of high magnesium calcite-secreting coralline algae. The Maldives would highly benefit from establishing a national network to monitor accretion rates, OA levels, and calcification rates in corals and calcifying algae. In addition to OA, land reclamation and nutrient pollution in the water column also pose substantial threats to the diversity of algae in the Maldives. Land reclamation processes can bury algae under sediments, thereby destroying their habitats. Nutrient pollution, often stemming from agricultural runoff or untreated wastewater, can trigger outbreaks of certain algae species. These outbreaks can be detrimental to other species, as the blooming algae can outcompete them for essential resources like light and nutrients, leading to decreased biodiversity.

The delicate balance within reef ecosystems is determined by the interaction among its key components: coral polyps, herbivorous fish, macroalgae, and macroinvertebrates, including sea urchins.

Reef health is also threatened by algae blooming.[237] The delicate balance within reef ecosystems is determined by the interaction among its key components: coral polyps, herbivorous fish, macroalgae, and macroinvertebrates, including sea urchins.[238] If herbivores are removed or algae growth exceeds the ecosystem's capacity to maintain equilibrium, it can lead to algae outcompeting corals for space on the reef. Furthermore, certain types of fleshy algae on reefs release an abundance of nutrients, specifically dissolved organic carbon. These nutrients serve as food for microbes, some of which can be harmful to reef ecosystems.[239] Monitoring algae populations in reefs is therefore fundamental to understand reef health in the Maldives.

Seaweed farms are increasingly considered an interesting economic alternative for coastal societies, particularly for women, as well as for the pharmaceutical and food industries.[240] This has been the case for sustainable seaweed farming

236 Li et al. (2020). https://www.sciencedirect.com/science/article/abs/pii/S1367912019304353?via%3Dihub

237 Healthy Reefs Initiative (2022). Mesoamerican Reef Report Card. https://www.healthyreefs.org/cms/wp-content/uploads/2022/12/2022_MAR_Report-Card_LOres-2.pdf

238 ibid.

239 National Science Foundation. (2022, June 14). Too much algae -- and too many microbes -- threaten coral reefs. NSF - National Science Foundation. https://beta. nsf.gov/news/too-much-algae-too-many-microbes-threaten-coral

240 UNEP. (n.d.). Seaweed Farming: Assessment on the Potential of Sustainable Upscaling for Climate, Communities and the Planet. https://www.unep.org/resources/report/seaweed-farming-assessment-sustainable-upscaling

A national monitoring system that properly captures the variability of different ecosystems is urgently needed to monitor and manage the Maldives natural capital.

in Zanzibar.[241] New opportunities for seaweed farming are also arising in carbon markets globally (e.g., seaweed farming for carbon in California).[242] The Maldives could benefit from the current development of new methodologies for seaweed and kelp farming for climate mitigation purposes under the voluntary carbon market (e.g., the VERRA Verified Carbon Standard).[243]

2.1.5 Recommendations

Natural capital lies at the core of the Maldivian economy. It is the pillar of its economic development and the long-term driver of the islands' shoreline stability. However, these ecosystems and their services remain poorly researched in the Maldives. The increasing human footprint on many Maldivian islands is detrimental to the country's reef ecosystems. Recommendations for enhancing the National Coral Reef Monitoring Program and National Coral Reef Restoration and Rehabilitation Program have been presented in the previous sub sections. This section presents several overarching recommendations.

A national monitoring system that properly captures the variability of different ecosystems is urgently needed to monitor and manage the Maldives natural capital. The Maldives reef monitoring system does not capture the country's reefs variability due to its limited number of plots and therefore does not provide an understanding of national status nor trends. In the meantime, efforts could be directed towards harmonizing methods and indicators that are collected locally by different stakeholders so that data can be integrated and provide better information at national scale than currently available. Monitoring should be annually (as committed by the Maldives in its NAPA report) but reporting could be biennial (as in other reefs). Less frequent reporting makes effective ecosystem management more difficult.

It's essential to identify and safeguard areas with high coral cover and resilience or abundant specific species for sustainable use and future protection.

Protect coral reefs under pressures from coastal development and climate impacts. This includes strengthening environmental and natural resource governance (see Chapter 4) and expanding the Marine Protected Area network to cover more of the country's reefs and enforcing strict protection in these MPAs (see Section 3.1). Protection could be aimed at prohibiting land reclamation activities and infrastructure development in the most sensitive areas. It's essential to identify and safeguard areas with high coral cover and resilience or abundant specific species for sustainable use and future protection. Given the increasing interest in reef restoration, careful management of species harvest is critical to avoid depletion of wild stocks.

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241 Ephrahim, K. V. (2018). Women and Seaweed Farming in Zanzibar-Archipelago. ResearchGate. https://www.researchgate. net/publication/326583845_Women_and_Seaweed_Farming_in_Zanzibar-Archipelagoooooooo

242 Law, S. C. F. C. C. (2022). Cultivating Seaweed for Carbon Removal in California: Barriers and Recommendations. State of the Planet. https://news.climate. columbia. edu/2022/06/29/cultivating-seaweed-for-carbon-removal-in-california-barriers-and-recommendations/

243 Verra. (2023, April 4). Methodology for Creation of Seaweed or Kelp Farms - Verra. https://verra.org/methodologies/methodology-for-creation-of-seaweed-or-kelp-farms/

Develop a nation-wide digital land and ocean monitoring system (e.g satellite and aerial sensors) to map and monitor key ecosystems, including coral reefs, mangroves, and seagrasses... in conjunction with reinforced ground monitoring efforts.

Impose protective measures for mangroves, particularly those affected by die-off, to preserve national diversity. Die-off stands can recover over time (approximately 15 years), but they must be actively protected from land reclamation, degradation, and deforestation, including by enforcing legal protection (see Section 3.1). Coordinated efforts and open dialogue among stakeholders working with mangroves are also crucial for tracking die-offs and sharing data.

Develop a nation-wide digital land and ocean monitoring system (e.g., satellite and aerial sensors) to map and monitor key ecosystems, including coral reefs, mangroves, and seagrasses. This system should work in conjunction with reinforced ground monitoring efforts (i.e., on-the-ground data collection), providing reliable and timely data to support ecosystem conservation policies. Regular measurement of sedimentation rates on islands and carbonate production in corals and calcifying algae should also be included in the system's capabilities. These capabilities are needed to be able to better integrate coastal dynamics into coastal infrastructure design (see Section 2.3.6).

Develop and implement a national plan to control human impacts on coastal and marine ecosystems. This plan should integrate planning across sectors (see Section 2.3.6) and address a wide range of issues, including reducing the damages from land reclamation on reefs, improving the planning of wastewater and solid waste management infrastructure, expanding the monitoring of waste(water) impacts on key reef health indicators (see Section 2.4.2), tracking and managing touristic visitation of coral reefs (see Section 3.2), and determining sustainable catch levels of the commercially most important reef fish species and incorporate these in reef fisheries management plans (see Section 2.2.5).

Enhance research efforts on algae to better understand their diversity, locations, health and trends.

Expand the coverage of long-term plots to capture reef variability in the country. This involves regularly measuring indicators such as coral cover, coral diversity, coral health, and other reef components like macro-algae, fish, and macro-invertebrates. The collected data should be promptly analyzed, and management responses should be implemented in a much shorter time frame than currently practiced.

Enhance research efforts on algae to better understand their diversity, locations, health and trends. More research is necessary to identify national hotspots of algae, particularly Halimeda, the calcifying algae; and Sargassum. Regular data collection on reefs should be maintained, and the data should be made available promptly (biennially).

Pilot the anthropogenic enrichment of lagoonal sediments to promote the proliferation of seagrass meadows. These pilots could offer valuable insights for large-scale restoration in the Maldives, and potentially attract funding under carbon markets.

The tuna fishery is community-based, with vessels being owned by individuals or by a family within a community and the crew sharing part of the profit instead of receiving a salary.

2.2 Fisheries

The fisheries sector in the Maldives is mostly community-based and has had minimal environmental impact due to its predominant use of pole-and-line and headline gear. Although relative significance of the fisheries sector has declined with the expansion of the tourism industry in the 1980s, tuna fishing remains a significant economic activity. The tuna fishery is community-based, with vessels being owned by individuals or by a family within a community and the crew sharing part of the profit instead of receiving a salary. The bycatch in the Maldivian tuna fishery is very low. A study conducted in 2014 - 2015 found 0.02 percent or 22 kg of bycatch (mostly Elagatis bipinnulata and Coryphaena hippurus) for every 100 tons of tuna caught[244]. Even in absence of similar studies since 2015, the bycatch has probably declined further as vessel monitoring systems (VMS) are in place and licensing and reporting of catches incl. bycatch has improved. Over the past years, the Maldives has started to transition from small-scale fisheries to more commercial fishing using more advanced technology in fleet and gear.[245]

Maldivian tuna fishers operate across the Maldives Exclusive Economic Zone (EEZ) where they extract tuna from fish stocks that are shared across the Indian Ocean region. Large pelagic species, particularly skipjack and yellowfin tuna, pass through the Maldives EEZ. The Indian Ocean Tuna Commission (IOTC) was established to promote collaboration and management of these shared natural resources (see Box 6).

Maldivian fishers also play an important role in maintaining food security in the country, which depends almost exclusively on fish as a source of protein.

Coastal fisheries, particularly live-bait and other species associated with reefs (primarily small fish species residing around coral reefs) are also critical in the Maldives. Reef fisheries mainly cater to tourists, recreational anglers, and to a lesser extent, commercial fishers targeting export markets. Pole-and-line tuna fisheries heavily rely on live-bait collected in reefs and lagoons. Therefore, tuna live bait is the one of the most vital reef fish resource in the Maldives, and its sustainability is crucial for the maintenance of the premium price it obtains for its eco-friendly pole-and-line caught tuna.

Fishers serve both the international and local fish market (see Figure 26). Large commercial companies primarily purchase three species of tuna (skipjack, yellowfin, and bigeye tuna) from the fishers, exporting a substantial portion of these catches. The majority of tuna is exported to Eastern Asia, Europe, and the USA (see Figure 25).[246] Certain species of reef fish and groupers are primarily exported to East Asian markets, such as Hong Kong, either live or chilled. Current export data reveals a decreasing trend in the export of live groupers,

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244 Miller, K. I., Nadheeh, I., Jauharee, A. R., Anderson, R. C., & Adam, M. S. (2017). Bycatch in the Maldivian pole-and-line tuna fishery. PloS one, 12(5), e0177391.

245 Jaleel, A. , & Smith, H. D. (2022). The Maldives Tuna Fishery: An Example of Best Practice. BRILL, 36(1), 314–345. https://doi.org/10.1163/22116001-03601012

246 FAO. (2019). The Maldives National Plan of Action to Prevent, Deter and Eliminate Illegal Unreported and Unregulated fishing. https://www.fao.org/3/ca7976en/ca7976en. pdf

while the export of fresh chilled groupers is on the rise. Live groupers typically fetch a higher price in the market. Maldivian fishers also play an important role in maintaining food security in the country, which depends almost exclusively on fish as a source of protein.[247] With improving access to imported sources of protein, fish consumption among locals has started to decline.

Box 6. The Indian Ocean Tuna Commission (IOTC)

The Indian Ocean Tuna Commission (IOTC) is a regional fisheries management organization tasked with overseeing the management of tuna and related fisheries in the Indian Ocean and adjacent seas. Established in 1993 and operational since 1996, the IOTC unites both countries bordering the Indian Ocean and nations with a vested interest in the region's tuna fisheries.

The IOTC aims to enhance cooperation among member nations for the conservation and optimal use of tuna stocks and to bolster the sustainability of the region's fisheries. For the Maldives, IOTC membership plays a critical role as it allows the nation to collaborate with other countries in managing regionally shared fish resources. Even before the IOTC's formation, the Maldives actively participated in the Indo-Pacific Tuna Program (ITPT), which initially compiled the tuna database. This program fostered exchanges of information between fishers and scientists, eventually leading to the establishment of the IOTC. The Maldives notably contributed a comprehensive tuna catch and effort database to this initiative.

Since the IOTC's inception, the Maldives initially held the status of a cooperating non-contracting party, enabling them to attend committee meetings and contribute scientifically. On July 11, 2011, the Maldives became a full member (cooperating contracting party) of the IOTC and has since been a very active participant. Current members of the IOTC include Australia, Bangladesh, China, Comoros, Eritrea, the European Union, France (on behalf of its overseas territories), India, Indonesia, Iran, Japan, Kenya, Korea, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Oman, Pakistan, Philippines, Seychelles, Somalia, Sri Lanka, South Africa, Sudan, Tanzania, Thailand, the United Kingdom, and Yemen.

Source: https://oceans-and-fisheries.ec.europa.eu/news/fisheries-agreement-reached-sustainable-management-bigeye-tuna-indian-ocean-2023-05-16_en.

247 FAO. (2016). State of World Fisheries and Aquaculture. https://www.fao.org/3/i5555e/i5555e. pdf

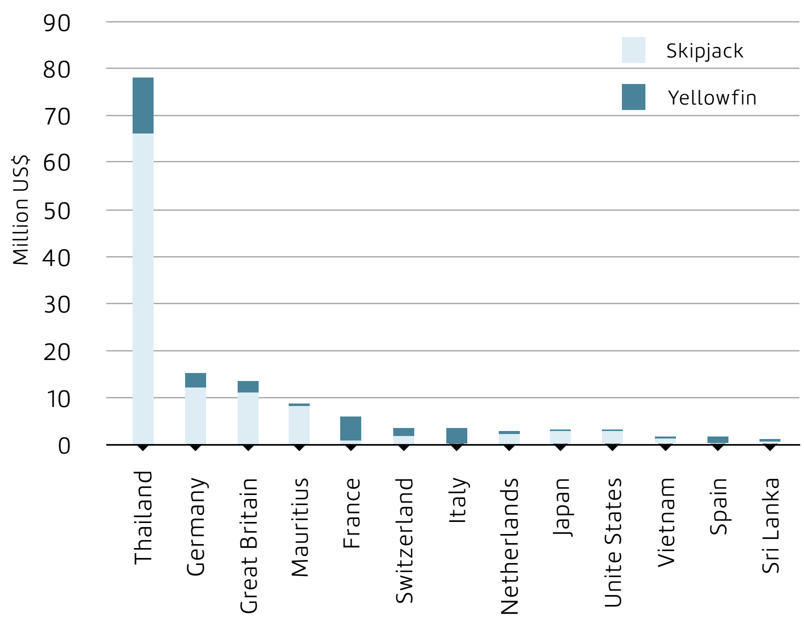
Figure 24. The IOTC aims to sustainably manage tuna fish in the Indian Ocean, including fish migrating to or from the Indian Ocean.

Geographic area of competence of the IOTC.

Source: https://oceans-and-fisheries.ec.europa.eu/news/fisheries-agreement-reached-sustainable-management-bigeye-tuna-indian-ocean-2023-05-16_en.

Figure 25. The majority of tuna products is exported to Thailand and European countries.

Total export value of yellowfin and skipjack tuna products in 2022, by destination

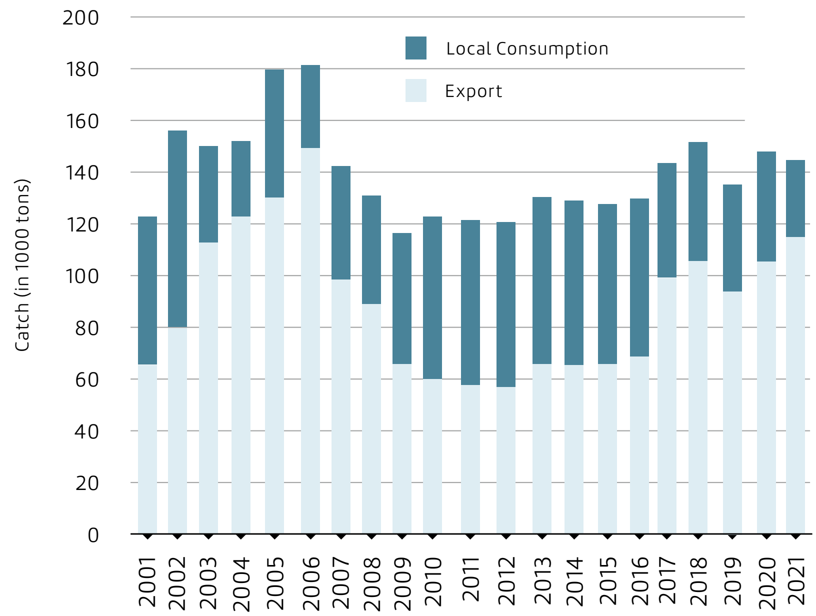


Source: World bank based on Maldives Customs Service

Aquaculture (fish farming) has been recognized as an important avenue for development in the Maldives.

Figure 26. Maldivian fishers supply to both domestic and international markets.

Catch for local consumption and export



Source: MoFMRA, MBS, 2022

Aquaculture (fish farming) has been recognized as an important avenue for development in the Maldives. However, its growth has been hindered by challenges such as limited access to finance, lack of demonstration of economically viable aquaculture operations, unavailability of attractive financing packages for investors, challenges in accessing markets, and a relatively unappealing risk-reward ratio. As a result, interested small to medium businesses and individuals have had difficulties to begin aquaculture ventures. Responding to the possibility that aquaculture may result in uncontrolled use of chemicals and mariculture effluents impacting marine environment, there is stringent restrictions on aquaculture in Maldives currently, which may also hinder the development of that sector. It will be important to have appropriate regulations to balance the need for expansion of mariculture suitable to the pristine marine environment in Maldives, attracting larger private investment and preventing possible escape of exotics and the use of avoidable chemicals. To that end, the MoFMRA will need to develop and mandate standard operating protocols acceptable in Maldives

There is a broad range of climate-related factors that may affect tuna and coastal fisheries in the Maldives, which will be explored in the upcoming Climate Change and Development Report (CCDR) of the Maldives. For example, hook and line is one of the primary fishing tactics, which is heavily dependent on live bait resources. Climate change-induced loss of corals might negatively affect live bait catch, which is currently already considered a concern by 22

The Maldivian tuna fishery is internationally recognized as eco-friendly because of the predominant use of sustainable fishing methods.

percent of Maldivian fishers.[248] Climate change can also lead to changing weather patterns around the Maldives, affecting the number of days fishers can venture out from the harbor for fishing. The CCDR that is currently being prepared for the Maldives addresses these and other climate-related issues in the fishery sector in more depth. The CCDR is a core diagnostic that integrates climate change and development considerations and helps prioritize the most impactful actions that can boost adaptation and reap development benefits. The CCDR will build on data and rigorous research and identify main pathways for fisheries (and other key sectors) that reduce climate vulnerabilities and promote sustainable development. The remainder of this chapter will focus on the sustainability of tuna and coastal fishing activities.

2.2.1 The sustainability of fisheries in the Maldives

2.2.1.1 Tuna fisheries

The Maldivian tuna fishery is internationally recognized as eco-friendly because of the predominant use of sustainable fishing methods.[249] Harmful techniques such as purse seine, trawl nets or large gill nets were never utilized for fish harvesting in the Maldives. Presently, most Maldivian fishers use hook and line fishing – primarily pole and line, which is used by 42 percent of fishers, and handline fishing, employed by 20 percent of fishers (see Table 3).[250] Large-scale use of nets and other destructive methods of fishing (such as using poison and dynamite) are banned in the Maldives. Small nets such as lift nets are used for harvesting live bait species while surround nets, cast nets, and set nets are used for catching reef-associated species for own consumption. Less than one percent of the fisherfolk was engaged in aquaculture, and about four percent[251] engaged in taking sea cucumbers, lobsters and other marine species.

Several of the regional tuna resources suffer from overfishing and depletion (Table 4), but the Maldives is a minor contributor to these issues. Of the total Yellowfin and Bigeye tuna catch in the Indian Ocean, the Maldives accounts for only 12 percent and 0.4 percent respectively (see Figure 27). Furthermore, the average Maldives Yellowfin catch between 2011-2020 (46,439 t) is also within the latest (2022) IOTC quota of 47,195 t (see Table 5).[252]

248 ibid.

249 FAO. (n.d.). IN FOCUS: Ending child labour in agriculture. https://www.fao.org/home/en

250 Maldives Bureau of Statistics. (2019). Household Income and Expenditure Survey 2019. https://statisticsmaldives.gov.mv/hies-2019/

251 The Government of Maldives ceased issuing licenses for longline fishery in July 2019 due to non-compliance of vessels and irregularities in the data reporting. Survey reports long line fishing done prior to July 2019.

252 The Maldives Journal. (2022). IOTC Sets Limit on Yellow Fin Tuna Catch For 2022. https://themaldivesjournal.com/33562

Table 3. Characteristics of the two main tuna fisheries in Maldives

	Pole and line fishing	Handline fishing
		
Target species	Skipjack and small yellow tuna (Fork length <70cm)	Large yellowfin (Fork length <70cm)
Certification	Marine Stewardship Council's (MSC's) certification for skipjack fishing (since 2012), N/A for yellowfin tuna	N/A
Targeted schools	AFAD, Free swimming, Log associated, Sea mounts	Dolphin associated, Free swiming and occasionally AFADs
Zone of operation	From coast up to about 75 miles throughout the Maldives	Throughout the EEZ – but mainly from coast up to 150 miles
Duration of a fishing trip	Single day or multiday trips depending ont he size of the vessel	Multiday trips last about a week
Number of crew members	8 to 35 – depending on the size of the boat	12 to 20 – depending on the size of the boat
Vessel length	Artisanal – 10 to 20 m Commercial – 20 to 35 m	20 to 35 m
Catch disposal	Commerical companies and local markets	Commercial companies
Main by catch	Kawakawa,frigate tuna, small bigeye tuna and rainbow runner	Sailfish, marlin
Frequently used livebait	Sprats, cardinal fish, fusiliers and anchovy	Scads, fusiliers and red tooth trigger fish

Source: http://www.bluepeacemaldives.org/mangroves/islands/neykurendhoo/, https://savemaldives.net.

Table 4. Stock status of the 5 most-caught species in Maldives

Species	Assessment Year	Depleted	Overfishing
Skipjack tuna	2020	No	No
Skipjack tuna	2018	Yes	Yes
Bigeye tuna	2019	No	Yes
Kawakawa	2015	No	No
Frigate tuna	-	Unknown	

Source: IOTC.

Table 5. In an effort to rebuild yellowfin tuna stocks IOTC allocates catch limits for the CPCs every year

IOTC yellow tuna catch limits in 2022.

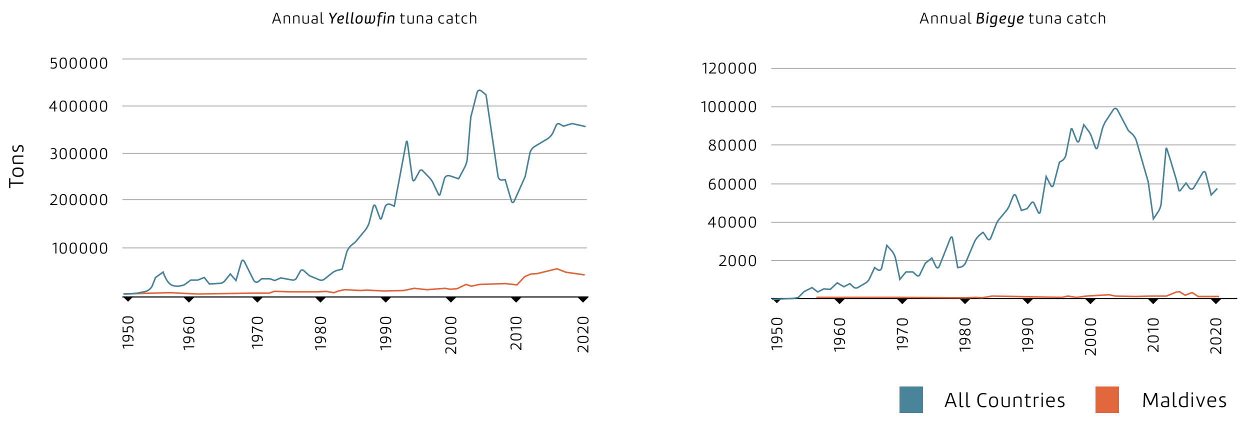
CPU	2022 catch limit (t)
Australia	2,000
Bangladesh	2,000
China	10,557
Comoros	5,279
Eritrea	2,000
European Union	73,146
France (Territories)	500
Japan	4,003
Kenya	3,654
Republic of Kenya	9,056
Malaysia	2,000
Maldives	47,195
Mauritius	10,490
Mozambique	2,000
Pakistan	14,468
Philippines	700
Seychelles	30,359
South Africa	2,000
Sri Lanka	31,066
Sudan	2,000
Tanzania	3,905
Thailand	2,000
United Kingdom	500
Yemen	26,262

Source: IOTC

The IOTC Resolution 21/01, which applies to all CPCs and fishers that harvest tuna and tuna like species within the IOTC area of competence, will provide additional advice towards reviving the tuna catches. This resolution, which comes into effect from 1st January 2024, provides scientific advice on fishing closure and precautionary measures towards improving the stocks. One of the measures includes that, from January 1, 2024 onward, all CPCs are encouraged to stop fishing for a minimum of 31 consecutive days. Alternatively, they could implement voluntary catch reductions.

Figure 27. The Maldives is a minor contributor to the depletion of Yellowfin tuna and the overfishing of Bigeye tuna in the Indian Ocean

Yellowfin and Bigeye tuna catch (in tons) in the Indian Ocean by Maldives (orange) and all IOTC members (black).



Source: IOTC

There have been no concerted stock assessments of Maldivian reef based fish stocks. This means that the status of these resources is poorly known. The lack of data for sound decision making puts these resources at risk of depletion, which could lead to significant economic and environmental damages in both the fisheries and tourism sectors.

2.2.1.2 Coastal fisheries

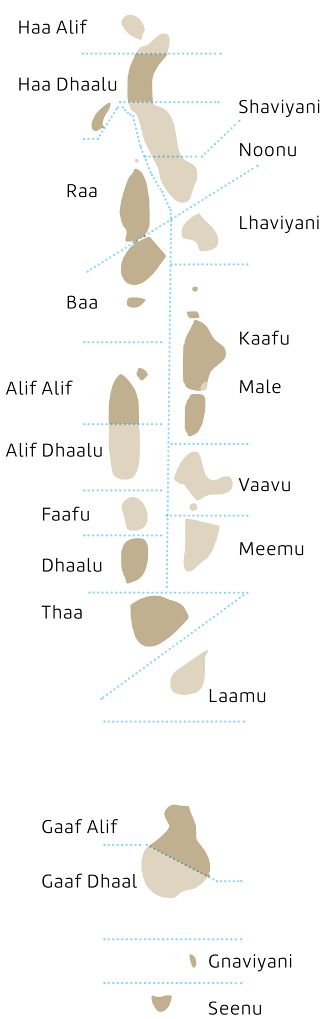
Coastal (reef and live bait) fishing is conducted for commercial and recreational purposes throughout the entire archipelago (see Figure 28). Reef fishers employ various methods like handline, jigging, , trolling, and spearfishing. Commercial reef fishers cater to the demands of the tourist industry and local markets, often with contracts from resorts or buyers. They target specific species based on buyer requests and sell directly to resorts. Another niche group targets reef fish for the export market, specializing in catching groupers and other reef fish, spending several days at sea. Recreational fishing is popular among tourists and locals, with some tourists visiting specifically for this purpose, arranging charters for catch-and-release practices. Some reef fishers use small boats for extra income, targeting reef-associated species and pelagics like billfish, wahoo, and dolphin fish on the outer atolls. They sell their catch to local islands, commercial buyers in Male', or resorts. While some reef fishers use live bait, majority of them use baited hooks to catch reef species.

There have been no concerted stock assessments of Maldivian reef based fish stocks. This means that the status of these resources is poorly known. The lack of data for sound decision making puts these resources at risk of depletion, which could lead to significant economic and environmental damages in both the fisheries and tourism sectors. Therefore, it's critical that the Maldives begins to assess stocks of the most economically important reef fish species, as these assessments are key to the development of effective fishery management plans.

Coastal fish stocks seem to be increasingly at risk of becoming overfished due to tourist demand for reef fish. Although reef fish export is limited and decreasing (from 500-600 tons in 2012 to 200-300 tons in 2019), tourist consumption of reef fish nearly doubled between 2009 and 2018 (from 4kt to 8kt per year) (see Figure 29).[253] This increase is consistent with the increase of the number of tourist beds during this time period (from 24,816 in 2009 to 45,419 in 2018). The increasing total tourism-driven demand for reef fish may compound the impacts of recreational reef fishing as well as ocean temperature hikes (see Section 2.2).

Figure 28. Reef fishing is practiced in all atolls

Number of active reef fishing vessels in 2022, by atoll.



Atolls	Small Vessels (4 to 6m)	Medium Vessels (6 to 15m)
Haa Alif	64	8
Haa Dhaalu	133	12
Shaviyani	167	23
Noonu	90	10
Raa	97	34
Baa	124	21
Lhaviyani	46	12
Kaafu	63	34
Alif Alif	89	35
Alif Dhaalu	52	28
Vaavu	23	6
Meemu	78	4
Faafu	42	56
Dhaalu	79	18
Thaa	180	11
Laamu	57	5
Gaafu Alif	76	4
Gaafu Dhaal	71	8
Gnaviyani	18	7
Seenu	38	3

Source: Island Councils.

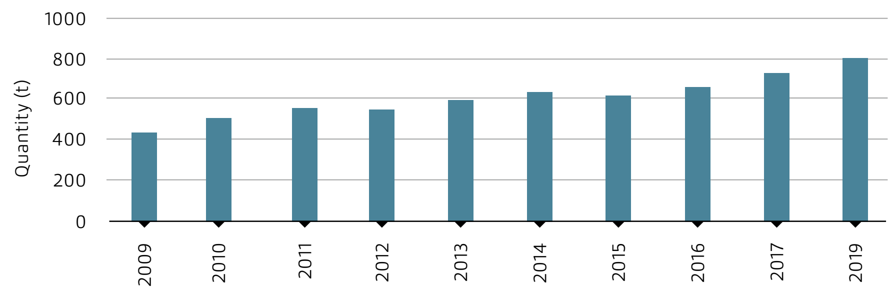
253 MoFMRA, cited by Jauharee, R. (2023) in An in-depth look at the Maldives fisheries. Unpublished Report.

Resorts have reported a perceived decline in the abundance and diversity of coastal fish available to purchase. Currently, about 74% of resorts purchase reef fish from local fishers, with an average purchase of 20.6 to 42.6 tons of fish per year.

Resorts have reported a perceived decline in the abundance and diversity of coastal fish available to purchase. Currently, about 74% of resorts purchase reef fish from local fishers, with an average purchase of 20.6 to 42.6 tons of fish per year.[254] However, around 37% of these resorts have reported a decrease in the quantity of fish available from local fishers and have noted a decline in the variety of fish offered.

Figure 29. Tourism demand for reef fish has almost doubled in the last decade

Estimated total reef fish purchased by resort hotels (in tons)



Source: World Bank based on MoFMRA (2019).

To improve the sustainability of reef fisheries, some community-based initiatives have been piloted with reef fishers supplying fish to resorts.

The coastal fish stocks also include live bait, which is important for tuna fishing. With the expansion of the tuna fishery, the demand for live bait has increased: pole-and-line live bait fisheries have grown sixfold between 1978-1981 (3,250 metric tons per year on average) and 2019 (19,230 metric tons per year).[255] The pole-and-line method of tuna fishing is dependent on the availability of live bait, which is primarily sourced from the reefs. The local tuna fishers mainly rely on netting out small demersal varieties of bait using lights at night. An estimated 15,000-20,000 tons per year of live bait are used in the Maldivian pole-and-line fishery. The forthcoming CCDR will include a modeling study of these and other impacts from coastal fisheries on marine ecosystems.

To improve the sustainability of reef fisheries, some community-based initiatives have been piloted with reef fishers supplying fish to resorts. One such initiative includes piloting a code of conduct for responsible reef fishing, which lays down a set of rules that both fishers and the resort agree to adhere to, ensuring sustainable fishing and trading practices. This code mandates that, within the allowed areas, fishermen concentrating on resilient species that are mature in size employ non-destructive fishing methods. To encourage adherence to this code, resorts back these fishermen through a points-based benefits scheme.[256]

254 World Bank & Ministry of Tourism led Environment and Climate Survey of Resort Islands (2023).

255 MoFMRA, cited by Jauharee, R. (2023) in An in-depth look at the Maldives fisheries. Unpublished Report.

256 ICRI (2020). Fishers sign up to first reef fishing code of conduct in the Maldives. https://icriforum.org/fishermenfishersto-first-reef-fishing-code-of-conduct-in-the-maldives/

2.2.2 The fragility of fishery-based livelihoods

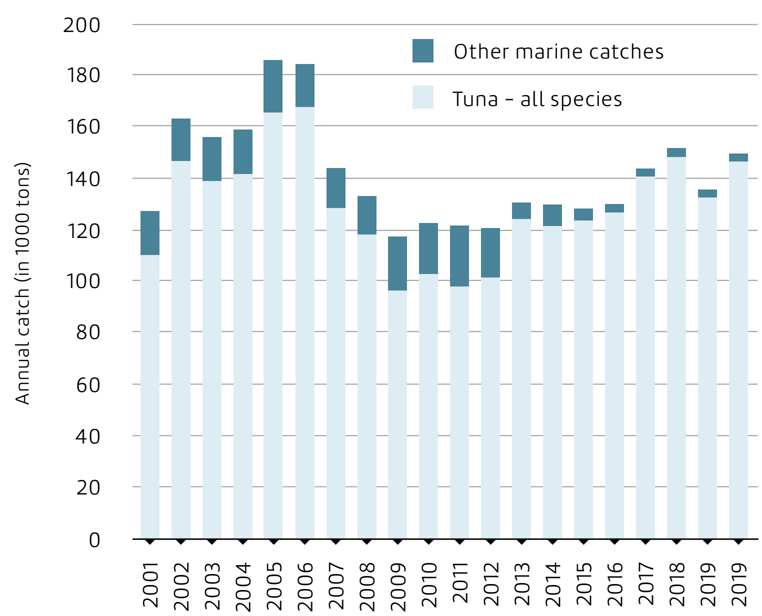
The fishing industry plays a crucial role in the Maldives' economy, contributing to approximately six percent of employment.[257] Most fishers reside on the atolls, making up 92 percent of the total.[258,259] Tuna fishing is the main activity for these fishers, with 76 percent involved in pole-and-line fishing and 22 percent in handline fishing. Tuna fishing is seasonal, with the optimal fishing locations and fish catch varying between the southwest (May-October) and northeast (December-April) monsoon periods.[260] Over the past two decades, there has been an increasing focus on tuna fishing with these two techniques. As a result, the proportion of the annual catch composed of tuna species has gradually risen from 75 percent in 2001 to 99 percent in 2020 (see Figure 30). The remaining one percent consists of other marine species including billfish, wahoo, barracuda, dolphin fish, snappers, groupers, emperors, jacks, rainbow runners, ornamental fish, and invertebrates such as sea cucumber, lobster and mollusks.

Tuna fishing is the main activity for these fishers, with 76 percent involved in pole-and-line fishing and 22 percent in handline fishing

Tuna fishing is seasonal, with the optimal fishing locations and fish catch varying between the southwest (May-October) and northeast (December-April) monsoon periods.

Figure 30. Maldivian fishers mainly focus on tuna fish

Total annual catch of tuna and other marine species harvested in the Maldives between 2001 to 2020 in thousand tons.



Source: MoFMRA and MBS, 2021

257 Maldives Bureau of Statistics. (2014). Maldives Population and Housing Census. Statistical Release 1V: Employment. https://statisticsmaldives.gov.mv/nbs/wp-content/uploads/2016/02/StatisticalReleaseIV-Employment. pdf

258 Maldives Bureau of Statistics. (2014). Maldives Census. https://statisticsmaldives.gov.mv/census-2014/

259 Maldives Bureau of Statistics. (2019). Household Income and Expenditure Survey 2019. https://statisticsmaldives.gov.mv/hies-2019/

260 Jauharee, A. R. , Capello, M. , Simier, M. , Forget, F. , Adam, M. , & Dagorn, L. (2021b). Tuna behaviour at anchored FADs inferred from Local Ecological Knowledge (LEK) of pole-and-line tuna fishers in the Maldives. PLOS ONE, 16(7), e0254617.

The fisheries sector plays a significant role in supporting local livelihoods and ensuring food security. It is the primary source of income for many households residing in the atolls, offering employment opportunities not only in fishing but also in local fish processing activities.

The fisheries sector plays a significant role in supporting local livelihoods and ensuring food security. It is the primary source of income for many households residing in the atolls, offering employment opportunities not only in fishing but also in local fish processing activities. Various processed fisheries products are locally produced by small-scale processors scattered across several islands. These products, destined for both domestic consumption and export, include smoked tuna, smoke-dried tuna, salt-dried fish, fish paste (rihaakuru), frozen tuna blocks/loins, frozen reef fish, and sea cucumber. Processing activities range from small-scale operations at the household level to medium-sized initiatives by registered processors. For 94 percent of those employed in the sector, fisheries serve as the main source of income.[261] Additionally, fish is a fundamental component of the Maldivian diet, contributing to a significant portion of protein intake. Remarkably, more than 70 percent of animal protein consumed in the Maldives comes from fish, which is considerably higher.[262]

Photo Description: Man scaling fish, Maldives © Shamveel Mufeed/Unsplash

261 ibid.

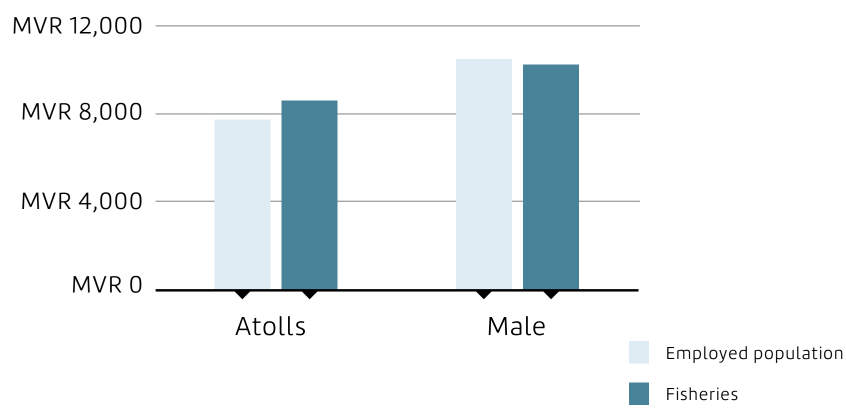
262 Maldives fisheries | Maldives Financial Review. (n.d.). https://mfr.mv/fisheries/maldives-fisheries

Fishery-based livelihoods are fragile despite fishers' income being on par with the national average income.

Fishery-based livelihoods are fragile despite fishers' income being on par with the national average income (see Figure 31). Tuna fishers earn more than reef fishers (see Figure 32). Between 2016 and 2019, the incomes of fishers decreased by one percent (in real terms).[263] This decline is reported by fishers as a major concern. Fishers are concerned that the fish prices set by the Maldives Industries Fisheries Company (MIFCO) will decline (reported by 29 percent of fishers), which they perceive would be a threat to the continuation of their fishing activities.[264] The specific role and impact of MIFCO on this issue, including their price-setting mechanisms, will be discussed in detail in subsequent paragraphs. However, it's important to note that fishery-based incomes fall below the national average even after factoring in the fuel price discounts offered by the Government of Maldives. These discounts, available to fishers registered in the duty exemption scheme, account for 19 percent of their incomes.[265] This means that fishery-based livelihoods are extremely sensitive to any potential policy changes that might reduce these discounts, underlining the precarious nature of the sector.

Figure 31. Fishers in Maldives have incomes that are comparable to the average income of Maldivians

Average incomes of fishers, compared with the rest of the employed population (non-fishers)



Source: World bank based in HIES 2019

Less than a third of Maldivian fishers have education beyond primary school, a rate that is about half the national average of 56 percent.

Maldivian fishers are vulnerable due to their general lack of job mobility, owing to lower levels of formal education attained. Less than a third (27 percent) of Maldivian fishers have education beyond primary school, a rate that is about half the national average of 56 percent.[266] The lack of formal education

263 Maldives Bureau of Statistics. (2019). Household Income and Expenditure Survey 2019. https://statisticsmaldives.gov.mv/hies-2019/

264 ibid.

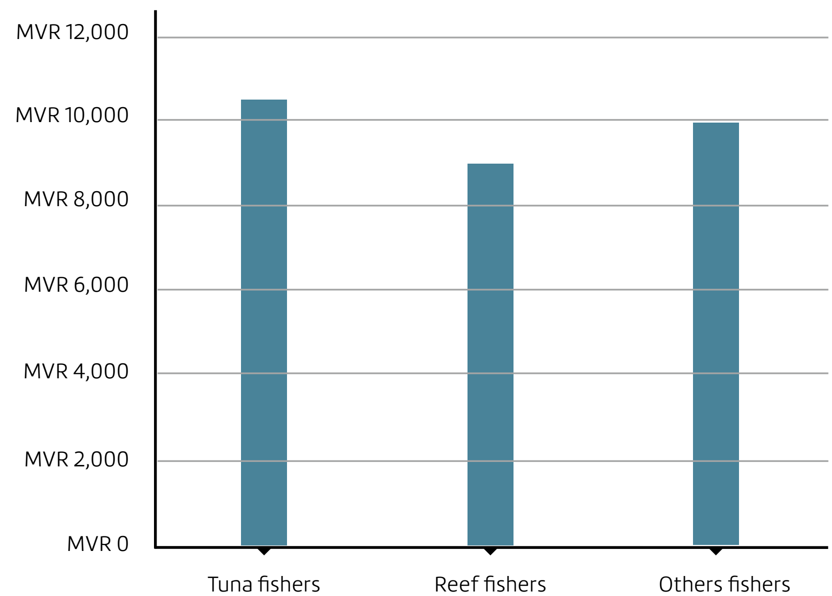
265 Schuhbauer et al 2020. The Global Fisheries Subsidies Divide Between Small- and Large-Scale Fisheries. Front. Mar. Sci., https://doi.org/10.3389/fmars.2020.539214

266 Maldives Bureau of Statistics. (2019). Household Income and Expenditure Survey 2019. https://statisticsmaldives.gov.mv/hies-2019/

among fishers may limit their ability to take up other jobs.[267] This will increase the risk of fishers becoming unemployed, if employment in the fisheries sector declines, as educational attainment is associated with other employment opportunity. More specifically, 64 percent of women and 73 percent of men within the unemployed population had limited or no education. Moreover, the risk of long-term unemployment is also higher for those with limited education: among those who have been unemployed for more than two years, 69 percent of women and 85 percent of men had limited or no education.[268] The general lack of education among the unemployed highlights the need for skill development through (post-)secondary education, which is a key determinant of the risk of unemployment.[269,270]

Figure 32. Tuna fishers earn more than reef fishers and other fishers

Average incomes of tuna, reef, and other fishers.



Source: World Bank based on HIES 2019

267 Sunny, R., Ismail, A., Hashim, M., & Naser, A. (2023). Exploring Strategies to Enhance TVET Engagement in Maldives to Improve Youth Career Development. Journal of Technical Education and Training, 15(1), 265-276.

268 Maldives Bureau of Statistics. (2019). Household Income and Expenditure Survey 2019. https://statisticsmaldives.gov.mv/hies-2019/

269 Mincer, J. (1991, September 1). Education and Unemployment. https://papers. ssrn.com/sol3/papers. cfm?abstract_id=226736

270 Sudan, F. K. (2021). Technological Disruptions, Youth Unemployment and Vocational Education Challenges in South Asia: A Short Report. Global Economics Science, 80–97.

A critical step to managing fisheries resources sustainably starts with having species-specific management plans. As of 2023, the MOFMRA has published 9 fisheries management plans...

2.2.3 Fisheries management and institutional arrangements

Photo Description: Woman buying tuna fish from fisherman, Maldives © World Bank

The Ministry of Fisheries, Marine Resources and Agriculture (MOFMRA) is tasked with overseeing fisheries-related activities, developing necessary regulations to ensure sustainable exploitation of fish stocks, and enforcing these regulations throughout the country. The main institutional framework for MoFMRA is the Fisheries Act, formulated and updated in 2019[271] which ensures sustainable

271 Government of Maldives. (2019). Fisheries Act of The Maldives Act No. 14/2019. https://www.gov.mv/en/files/fisheries-act-of-the-maldives. pdf

To help develop the fisheries sector, the GoM has invested substantially in fisheries-related infrastructure facilities in the past decades.

management of fisheries and their ecosystems within Maldivian maritime zones. The act also controls fishing activities within these zones and the activities of Maldivians outside these zones, and outlines the principles for the development and management of fisheries and aquaculture industries. The act mandates the development and implementation of management plans for all commercial fisheries, including those targeting tuna and tuna-like species.

A critical step to managing fisheries resources sustainably starts with having species-specific management plans. As of 2023, the MOFMRA has published 9 fisheries management plans, including for tuna fishery, billfish fishery, general reef fishery, grouper fishery, lobster fishery, sea cucumber fishery, aquarium fishery and diamondback squid fishery. A management plan for live bait fisheries was developed in 2013. As far as the two most important fisheries are concerned, the tuna fisheries management plan focuses on maximizing economic benefits, ensuring food security, and improving monitoring, control, and surveillance. The general reef fishery management plan emphasizes the need for responsible management and sustainable development of reef fisheries in its main objectives. At present MOFMRA is building the advisory committees that have to be appointed under the respective management plans. The Maldives has also submitted a fishery management plan specifically for fishing near Anchored Fish Aggregating Devices (AFADs) to the IOTC in 2014. It is expected that management plans will strengthen monitoring and management of the fisheries.

To help develop the fisheries sector, the GoM has invested substantially in fisheries-related infrastructure facilities in the past decades. Initial efforts saw the transformation of the fishing fleet from sail to motor by providing engines and interest-free loans for engine purchases. Later, fishing vessels were constructed and distributed to communities, and ice plants, fish processing plants, and cold storage facilities were established. The GoM also supported fishers in installing refrigerated seawater (RSW) systems on their vessels, developed harbors on almost all islands, and deployed anchored fish aggregation devices throughout the Maldives. The use of large-scale nets for fishing, and the use of dynamite or poison, were banned to promote sustainable fishing practices. However, it should be noted that diesel fuel, used to power fishing vessels, contributes to high operating costs and environmental impacts from potential pollution and emissions.

The Maldives Seafood Processors and Exporters Association (MSPEA) is a registered NGO working to promote Maldivian fish and fisheries products for its members (exporters and processors). MSPEA's ambition is to make "Maldives Tuna" a household name by promoting the Maldives one-by-one Tuna fisheries and its low ecological impact with its cultural and social context throughout the developed world for customer recognition and premium pricing. MSPEA works closely with MOFMRA. Exporting member companies of the MSPEA pay a small commission for the certification maintenance, which the Maldives obtained for skipjack pole and line fishery in October 2012.

Since 1993, MIFCO has been instrumental in revolutionizing the fishing industry of the Maldives by enhancing the commercial value of the daily catch.

The marketing, sales, and operations in the Maldivian fisheries sector is greatly supported by the Maldives Industrial Fisheries Company (MIFCO), which is a state-owned company established with the goal of creating economic opportunities for local fishing communities. Since 1993, MIFCO has been instrumental in revolutionizing the fishing industry of the Maldives by enhancing the commercial value of the daily catch (see Figure 33). It has set up cold storage facilities and a canning plant to buy fish from local fishers and process them. MIFCO also operates a fleet of vessels that venture to the outer atolls to purchase fish, making it the primary buyer of skipjack tuna in the Maldives. Through MIFCO, the government ensures that fishers receive a steady price for their catch. In 2023, the average price of tuna weighing over 1.5 kg ranged between USD 0.97 (Rf 15.00) and USD 1.10 (Rf 17.00) per kilogram. This set price discourages potential competitors from undercutting MIFCO, particularly if their proposed price exceeds what a free market would dictate. Tuna weighing less than 1.5 kg is generally declined by tuna purchasing companies and only occasionally bought for staff consumption. This policy encourages fishers to target mature tuna, thereby protecting juvenile populations. In 2022, MIFCO disbursed over US$ 65 million (MVR1 billion) to fishers for tuna purchases. While the Ministry of Fisheries, Marine Resources and Agriculture (MOFMRA) has advocated for island communities to establish fishery cooperatives, however no such cooperatives currently exist.

Through MIFCO, the government ensures that fishers receive a steady price for their catch.

MIFCO, has faced numerous challenges throughout its operation. Initially, as a state-owned enterprise, it enjoyed monopoly status, but this was rescinded by the government in 2000 to foster competition. Financial stability has been a consistent concern; after initially approaching a break-even point, falling tuna prices, rising fuel prices, and higher interest rates led MIFCO to significant losses. These losses forced the government, as MIFCO's guarantor, to service its debt. While efforts to restructure and improve quality control allowed for brief periods of profitability, by the 2010s, a decision to trifurcate MIFCO into three separate entities failed to generate the expected financial outcomes. Further, after reconsolidation, the restructured state-owned entity struggled to pay fishers due to accumulated debts. Even as a subsidiary of the State Trading Organization, MIFCO's financial woes persisted. High operational costs and an emphasis on exporting to intermediary markets instead of direct-to-destination markets, where better prices could be fetched, also hindered profitability. The government's decision to pay higher prices to fishers for their catch through MIFCO, presumably to maintain interest in the fishing sector, further strained the company's financials. The government's current approach leans on enhancing MIFCO's processing capabilities through various infrastructural investments, aiming to realize higher export values. However, there is a greater need to address organizational inefficiencies and the persistent reliance on intermediary markets.

The government's current approach leans on enhancing MIFCO's processing capabilities through various infrastructural investments, aiming to realize higher export values.

Figure 33. MIFCO plays an important role in the value-chain of Maldivian fisheries

MIFCO vessel purchasing tuna from local fishers.

Photo Description: Vessel purchasing tuna © Riyaz Jauharee

Photo Description: Fishing Dhoni, Thimarafushi, Thaa Atoll Maldives © World Bank

Box 7: Potential Reform Pathways for MIFCO: Evaluating the Options

Given the numerous challenges faced by MIFCO over the years, it's evident that a restructuring of the organization is imperative. Broadly, the restructuring possibilities boil down to these four key viable options, each warranting thorough scrutiny.

Option 1: Maintaining MIFCO under STO with Enhanced Capacities: As per the current government's plan, MIFCO will remain a subsidiary of STO, with a focus on expanding its value addition capabilities. The strategy aims to increase canned tuna production and reduce fresh/frozen tuna exports to boost gross revenue by an estimated 30%, ensuring the State-Owned Enterprise's (SOE) financial stability. Concerns include the potential for increased inefficiencies due to MIFCO's high operational costs and the challenge of accessing European and American markets directly, given its historical reliance on intermediaries. It's worth noting that while some private Maldivian entities have succeeded in these markets, MIFCO may not replicate their success. Additionally, by potentially outbidding private firms in fisher purchases, MIFCO could deter private sector investments, which may contradict the government's goal of promoting private-sector growth.

Option 2: MIFCO Privatization with Direct Subsidy Transfers to Fishers: Reflecting on previous privatization attempts from 2004-10, the proposal for MIFCO's privatization brings with it a series of crucial questions. These include: (i) Should MIFCO be privatized as a single entity or be segmented into 3 or more units for individual privatization? (ii) Prior to a full sell-off, should MIFCO or its divisions be transformed into public limited companies, potentially elevating their market value? (iii) Will the emerging private enterprises be mandated to ensure a minimum floor price when purchasing from fishers? If executed meticulously, privatization could relieve the government of MIFCO's persistent financial burdens and liabilities. However, this would necessitate the government to then directly subsidize fishers to meet social objectives, given that a private firm would be less likely to pay above the MoFMRA's regulated floor price. At present, the government's subsidies are confined to MIFCO purchases since other private entities have some capacity to process and sell canned tuna. A total privatization would require the government to expand its subsidy approach to encompass all purchases.

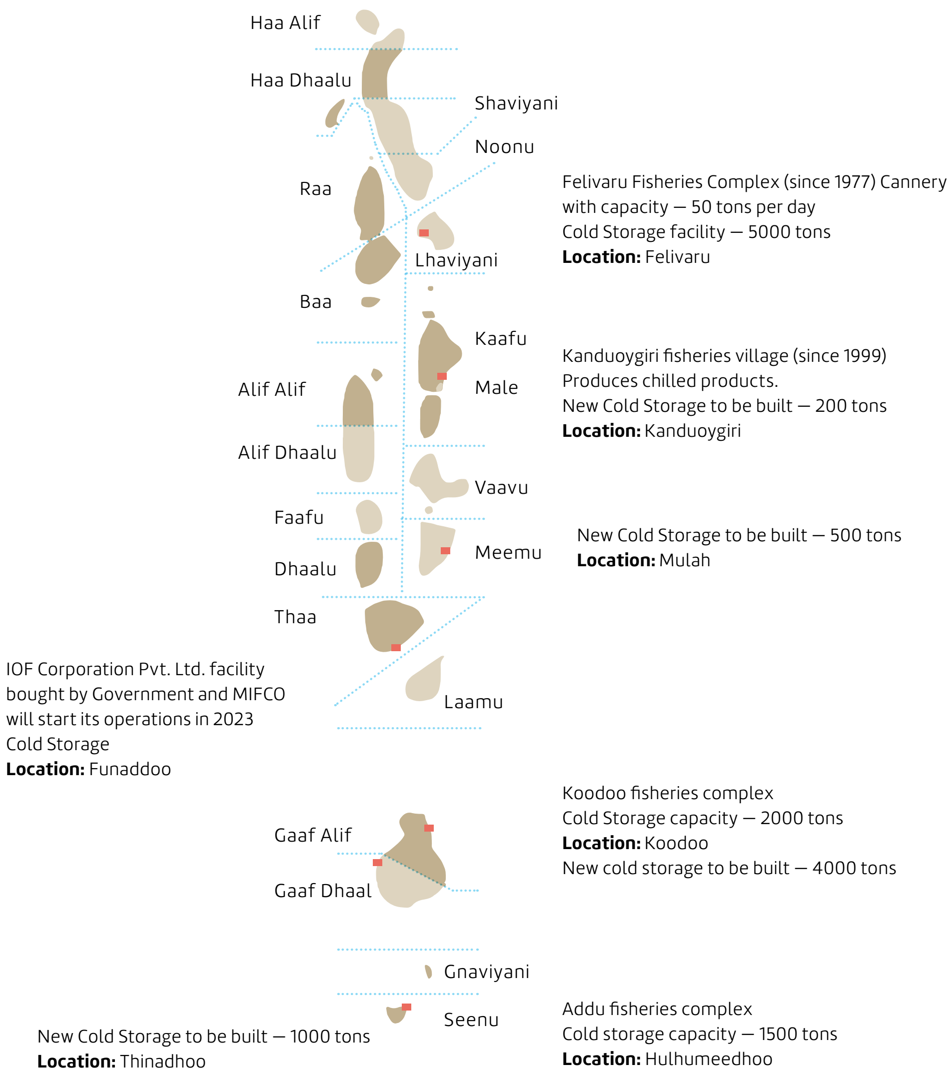
Option 3: Transform MIFCO into an Operationally Independent Public Limited Company: The third proposal emphasizes converting MIFCO into a public limited company that operates with considerable autonomy and independent management. The primary focus of this restructuring would be to address and rectify operational inefficiencies, with clear targets set for cost reduction. Once the company streamlines its operational costs, the strategy could shift towards gradually offering increased shares to private investors. Politically, this avenue might encounter fewer obstacles as there seems to be a prevailing consensus in favor of such a transition. This hands-off approach allows the government to mandate purchases at prices surpassing the floor rate without involving itself in day-to-day management. However, this might temper the government's ambition to entice substantial private investment.

Option 4: Restructuring MIFCO with a Clear Division between Public Procurement and Commercial Operations: This proposition involves bifurcating MIFCO's roles: one portion operates as an SOE focused on public procurement, providing cold chain services, while the other segments handling processing, canning, and exporting transition into private enterprises. By distinguishing between

MIFCO's social responsibilities and its commercial pursuits, this reconfiguration ensures that fishers get a more equitable slice of the sector's net revenue. By monopolizing tuna procurement, this state-run entity can streamline efficiencies, level the playing field for smaller private companies, and address their scale disadvantages. This reimagined SOE would then act as the primary supplier of tuna to all private processing and canning ventures in the Maldives. Furthermore, with the proposed expansion of cold storage facilities, this entity could offer pivotal cold chain services, reducing storage expenses and fish wastage. However, several challenges need tackling: 1) Determining an optimal pricing model for supplying fish, with or without cold chain services, to private enterprises. One consideration could be setting prices parallel to those in intermediate export markets, minus associated costs like shipping; 2) Managing the balance between exports and meeting the demands of local businesses based on their processing capacities; 3) Ensuring equitable distribution of sales volumes among private players, especially during lean fishing seasons. As an integral aspect of this option, there's a push for privatizing existing and in-progress canning and processing facilities, and any public investments slated for such infrastructures should be shelved in favor of exclusively private investments.

Analyzing the varied contexts and presented options, determining the future of MIFCO isn't just about financial viability; it's also about aligning with the social imperatives of the fisheries sector. The pursuit of profitability or mitigating national revenue losses cannot overshadow the fundamental goal: ensuring a thriving fisheries sector that benefits Maldivian fishers, as underscored by the unsuccessful privatization efforts from 2002 to 2016. A meticulous evaluation of each option is essential, emphasizing feasibility, public liability concerns, and implementation challenges. The forthcoming TransFORM project assessment aims to provide a comprehensive comparative analysis, which will guide the MCGP on the necessary support to seek from the World Bank.

Figure 34. Location of existing MIFCO facilities and newly proposed facilities for purchasing tuna from local fishers

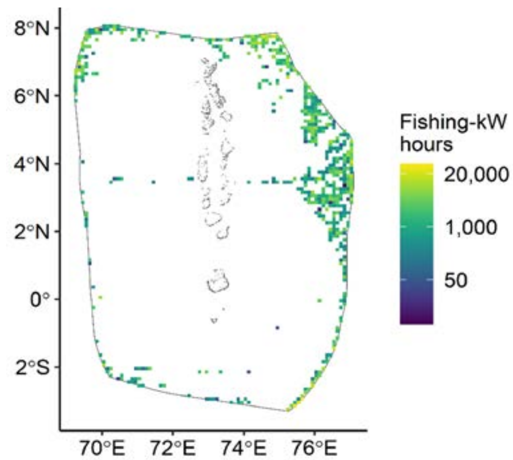


Unauthorized fishing by foreign vessels in Maldivian waters is a problem. Vessels are unauthorized to fish in Maldivian waters if they are "flagged" or registered in a country other than the Maldives. Data from the organization Global Fishing Watch (GFW), which captures 50-70 percent of fishing effort, shows that absolute foreign fishing effort[272] in the Maldives Exclusive Economic Zone is low. Between 2016 and 2020, a total of 4,218 hours of foreign fishing activity was recorded, which equates to a single vessel fishing for 10 hours a day for just 85 days per year (see Figure 35). However, since 2021, 23 vessels have been prosecuted for IUU fishing within the exclusive economic zone of Maldives.

272 Kroodsma, D. , Mayorga, J. , Hochberg, T. , Miller, N. H. , Boerder, K. , Ferretti, F. , Wilson, A. C. , Bergman, B. , White, T. J. , Block, B. A. , Woods, P. , Sullivan, B. K. , Costello, C. , & Worm, B. (2018). Tracking the global footprint of fisheries. Science, 359(6378), 904–908. https://doi.org/10. 1126/science. aao5646

Figure 35. Most unauthorized fishing by foreign vessels occurs near the Maldives EEZ boundary

Apparent unauthorized foreign fishing effort, 2016–2020



Source: World Bank own calculations

Even when considering the disabling of vessel transponders, which could obscure unauthorized fishing activity in Maldivian waters,[273] there seems little reason for concern. Transponder disabling near Maldivian waters is infrequent compared to hotspots near West Africa, Argentina, and the Northwest Pacific, obscuring probably less than 10 percent of vessel activity in Maldivian waters.

Transshipment, the practice of transferring a fishing vessel's catch to a carrier vessel at sea rather than at a port, which could aid unauthorized fishing, is also uncommon in Maldivian waters. Global Fishing Watch transponder data indicates that this is a rare occurrence. This data recognizes "encounter events", where a fishing vessel and a carrier vessel remain in close proximity at sea for at least two hours, and "loitering events", where a carrier vessel moves very slowly at sea for at least one hour. These loitering events could signify transshipment, as fishing vessels are more likely to disable their transponders when near carrier vessels. However, between 2016 and 2020, no encounter events (indicating likely transshipment) were found outside the Maldives' atoll rim, and only a small number of loitering events were recorded. Thus, transshipment doesn't appear to be a significant issue in the Maldives.

The extent of unauthorized fishing by domestic vessels is less clear and needs further investigation. Domestic vessels are considered unauthorized if their name does not appear on the government's annual list of authorized vessels.

273 Welch, H., Clavelle, T., White, T. J., Cimino, M. A., Van Osdel, J., Hochberg, T., Kroodsma, D., & Hazen, E. L. (2022). Hot spots of unseen fishing vessels. Science Advances, 8(44). https://doi.org/10.1126/sciadv.abq2109

Only three domestic vessels were classified as unauthorized between 2016 and 2020 because these vessels did not carry a valid fishing license. As of 2023, installation of an acceptable vessel locating device (VLD) and obtaining a satellite connection for the VLD is part of the licensing requirement for any vessel of length 18 m or more. Further, it is difficult for a fishing vessel to engage in commercial fishing without a license, as processing facilities do not accept offloading from vessels without valid licenses. Therefore, chance of unauthorized fishing is limited in the exclusive economic zone. However, vessels smaller than 18 m in length are not necessarily licensed, do not have transponders, and even if many of these vessels are involved in nearshore fishing, chances are there that some may venture into wider sea. Gaining a better understanding of unauthorized fishing by domestic vessels, particularly in marine protected areas located closer to the shores, is a priority for fisheries management. While having a Vessel Monitoring System (VMS) is a part of licensing requirements for commercial tuna fishing vessels, the compliance section of the Ministry of Fisheries, Marine Resources, and Agriculture (MoFMRA) possibly need further improvement in its fisheries monitoring system, and a possible introduction of licensing along with mandatory installation of transponders in smaller fishing vessels including vessels engaged in reef fishing including a focus on tracking and monitoring of fishing within MPAs.

2.2.4 Fiscal policies in the fisheries sector

Fossil fuel subsidies, such as direct cash compensation and providing diesel at below-market rates, can inadvertently contribute to overfishing and depletion of oceanic fish stocks. Although subsidies can help protect fishery-based livelihoods in the face of volatile and rising fuel prices, they also increase fishing because they artificially lower operating costs. This increases the risk that the total amount of fish caught exceeds the rate at which fish stocks can replenish. The harmful impacts of fishing activities increase accordingly. Fossil fuel subsidies can also attract new fishers for whom market entrance would otherwise not be profitable. Fossil fuel subsidies as related to fishing are thus harmful for the marine environment and do not contribute to a sustainable Blue Economy. That said, such risk of overfishing is a risk for the future, as currently, the Maldives tuna catch is below the quota allotted by IOTC.

Maldivian fishers purchase diesel at below-market rates. The Maldives Industries Fisheries Company (MIFCO), a subsidiary of the State Trading Organization (STO), sells diesel to fishing vessel owners at a 22 percent discount. As of the end of 2022, MIFCO sold diesel to fishers at a rate of Rf 17.63 per liter (US$ 1.15), whereas the general public paid Rf.66 per liter (US$ 1.47) (see Figure 36).[274]

274 Dhauru. (n.d.). MIFCO in masverinnah diesel vikka agun MVR 3 bodu koffi. https://dhauru.com/post/business/9379

275 Maldives Industrial Fisheries Company Limited. (2021). Diesel Price Change [Digital image]. Retrieved from [https://www.facebook.com/mifcomv/photos/a.1381047005482075/2909161149337312/?type=3%5C

Figure 36. MIFCO offers diesel at below-market rates

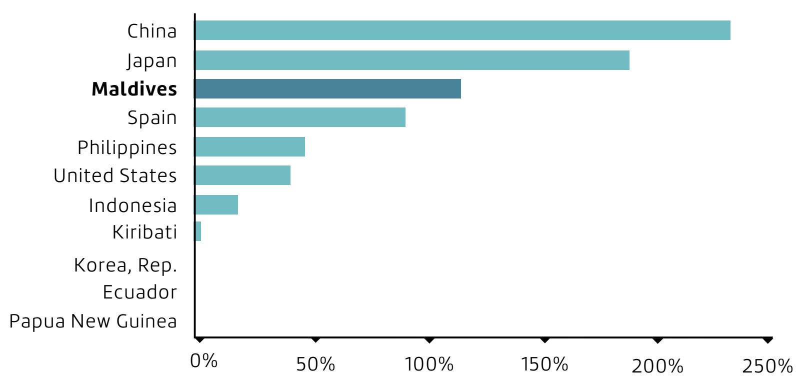
MIFCO announcement of price changes

Source: MIFCO, 2021 [275].

Fishers can receive a 5 percent duty exemption by enrolling in the governmental Fahi Hakatha program. This duty exemption can be obtained via applying for subsidy tokens in a mobile application on a monthly basis.[276] As part of its Strategic Action Plan, The Government of Maldives aspires for 75 percent of fishers rolled in the Fahi Hakatha program by 2023. In 2018, the fuel subsidy per metric ton of fish catch stood at US$ 115, a relatively substantial subsidy when compared to several major tuna-fishing countries (as shown in Figure 37). However, net profit or margins for fishing vessels had been claimed to be inadequate even with this fuel subsidy, and the Government of Maldives have addressed this issue of falling subsidies by directing MIFCO to buy fish much above the floor price set by the MoFMRA.

Figure 37. Fuel subsidies per ton of fish caught are similar to those in other major tuna-fishing countries

Fuel subsidies in the fisheries sectors of major tuna-fishing countries.



Note: *Fish catch refers to the total landed weight of seven major fish species.*

Source: Own calculations[277]

276 Zunaam, F. (2020, October 1). MIFCO lowers diesal rates for fishing vessels again. The Times of Addu. https://timesofaddu.com/2020/10/01/mifco-lowers-diesal-rates-for-fishing-vessels-again/

277 Calculations are based on capture fisheries production in 2018 (FAO estimates) and fuel subsidies in 2018 estimated by Schuhbauer.

Subsidy reforms in the fisheries sector have significant risks for livelihoods and need to be addressed with great care. Downward pressure on the market price of fish is the foremost concern among these households.

Fishers are offered fixed floor prices. The floor price stipulated by the MoFMRA, effective September 2020, is Rf13 (US$ 0.84) per kilogram for skipjack tuna weighing more than 1.5 kilogram or Rf5.5 (US$ 0.36) per kilogram for fish weighing less than 1.5 kilogram. The 2020 floor prices were set up replacing the 2010 prices (Rf7 and Rf3.5, respectively) to ensure that the fishers receive a fair share of the price at which frozen or chilled fish is marketed/exported. Fish prices are equal to the floor price when the global market price is less than the floor price. Fish prices will follow the global market price in times when it exceeds the floor price. For example, the price dip in the global market price in 2019 would have caused large revenue losses for Maldivian fishers without the floor price being in place. Thus, price controls contribute to the livelihood of Maldivian households that are dependent on fishing. Floor (minimum) prices of fish are regulated under the Fisheries Act (Regulation No: 2020/R-93).[278] However, the government owned enterprise, MIFCO is regularly directed to purchase fish at prices higher than the floor price set up by the MoFMRA. As of Q3 2022, MIFCO purchased skipjack, iced skipjack, and yellowfin tuna at prices Rf 15 (US$ 0.98), Rf 17 (US$ 1.11), Rf 89.3 (US$ 5.80), respectively.[279] More recently, in the summer of 2023, the prices offered by MIFCO were increased even more. For instance, the price for skipjack tuna was increased to Rf 25 (US$ 1.62). The higher price that MIFCO pays to fishers for buying tuna is not because the global market price is increasing, but arguably to protect fishing revenues in times when global market prices for fish are dwindling on one end, and the cost of fishing is increasing at the other.

Employment in the fisheries sector in remote atolls is twice as high (14.4 percent) as the national average (6 percent).

There are also domestic downsides to the support offered to the fishers on top of the fiscal cost. The current subsidies for fisherfolk described above, inflate revenues in the fisheries sector and risk to incentivize overfishing and excess fleet capacity (although at present the Maldives is within the IOTC quota). In addition, higher prices for fish make domestic value chain development harder. While the subsidies in for fishing are increasing the profit margins of the fishing fleet, they are at the same time decreasing the profit margins of fish processors (such as canning), except for the state-owned MIFCO who periodically receive grants from the government to cover the revenue loss. This threatens the viability of existing processing activities, viability of private sector investments, and the development of the value chain.

Subsidy reforms in the fisheries sector have significant risks for livelihoods and need to be addressed with great care. Downward pressure on the market price of fish is the foremost concern among these households.[280] Removing fish subsidies will have significant effects on the bottom line of the fishing vessel fleet and have potential impacts on jobs. The effects of changing

278 Ecolex. (2020). Regulation No: 2020/R-93 on minimum price for sales and purchase of fish. https://www.ecolex.org/fr/details/legislation/regulation-no-2020r-93-on-minimum-price-for-sales-and-purchase-of-fish-lex-faoc207523/

279 Maldives Monetary Authority. (2022). QUARTERLY ECONOMIC BULLETIN: Vol. 28 Issue 3 (Third Quarter). https://www.mma.gov.mv/documents/Quarterly%20Economic%20Bulletin/2022/QEB-Q3-2022. pdf

280 Usman (2022). Maldives Fisheries Sector Analysis. Third draft. Unpublished report

fish floor prices and fossil fuel subsidy changes should thus be carefully assessed and only be considered in combination with measures that mitigate distributional impacts. Without additional measures, subsidy removals could disproportionately affect remote islands and populations heavily dependent on fishing. Employment in the fisheries sector in remote atolls is twice as high (14.4 percent) as the national average (6 percent). The average income among fishers is Rf 8,558 per month in 2019. Although this is 11 percent higher than the average income in atolls (Rf 7,716), it is 18 percent lower than the national average income which includes jobs performed in Malé (Rf 10,474[281]). Therefore, any subsidy reform should be coupled with measures that protect the lowest-income households, such as direct cash compensation, essential goods tax reductions, and non-fisheries sector employability training programs.[282]

2.2.5 Recommendations

Short-term recommendations

Improve the ecological and economic understanding of reef and live bait fisheries. This involves mapping the distribution of fishing grounds and breeding sites, quantifying stocks of key exploited or vulnerable species, and enhancing data collection on reef fish consumption. Biological studies of bait fish species would offer critical insights into the interconnectivity of different atoll populations, and prioritization of the enhancement of fish and shellfish landing statistics within the fisheries sector should be drawn from the Fisheries Statistical Capacity Assessment Tool (F-SCAT). The comprehensive nature of F-SCAT statistical capacity assessment tool, capturing both economic (e.g., costs, earnings, subsidies, licensing, imports, and exports) and social (labor and gender) dimensions, makes it particularly useful.

Employ quantitative stock assessments to determine sustainable catch levels and/or other appropriate management measures of the most commercially important reef and bait fish species and incorporate these in fisheries management plans as well as in the declaration and management of MPAs. It's currently unclear whether current catch levels are sustainable; these metrics can identify necessary changes to reduce adverse impacts on fish stocks. The latter can be achieved by legally protecting fishing grounds where stocks are at risk of degradation or depletion by declaring additional MPAs (see recommendations in Section 3.4). Stock assessments could also improve the design of appropriate mitigation action to reduce the development impacts on fishing grounds as part of the EIA process (see Section 4.5).

Conduct a detailed value-chain analysis to identify challenges and opportunities in the fisheries sector. This analysis should identify key constraints in the value-chain, including by reviewing existing domestic

281 Maldives Bureau of Statistics. (2019). Household Income and Expenditure Survey 2019. https://statisticsmaldives.gov.mv/hies-2019/

282 OECD. (2021). Update On Recent Progress in Reform of Inefficient Fossil-Fuel Subsidies That Encourage Wasteful Consumption. https://www.oecd.org/fossil-fuels/publicationsandfurtherreading/OECD-IEA-G20-Fossil-Fuel-Subsidies-Reform-Update-2021. pdf

and international market channels, the profits and costs of key market chain actors, and challenges in the fish processing, storage, and transport capacity that may hold back the development of the fisheries sector. Such an analysis can suggest interventions that heighten the operational efficiency of key players, like fishers, processors, and MIFCO. An example might be promoting the use of Refrigerated Sea Water (RSW) systems on fishing vessels, which could bolster profitability by minimizing post-harvest loss, but the current adoption rate of these systems needs to be grasped before implementing targeted interventions. Moreover, despite the relative fuel efficiency of Maldivian pole-and-line fisheries,[283] this analysis might expose potential inefficiencies like overconsumption of fossil fuels due to oversized fishing vessels and fossil fuel subsidies. Finally, the analysis could highlight ways to enhance the marketing of premium fishery products.

Photo Description: Local Monument with the Folded Hands and Blue Water Drop in Maldives © World Bank

Diversify economic activities in the fisheries sector. This can provide a safeguard for fishers currently solely reliant on capture fisheries, protecting them from income drops resulting from macroeconomic shocks. Previous initiatives, like the Maldives Sustainable Fisheries Resources Development Project, have backed the development of mariculture, specifically for grouper and sea cucumber. Building on this, the Maldives should further encourage diversification into aquaculture, complete with supporting facilities and a

283 Miller, K. I. , Adam, M. S. , & Baske, A. (2017). Rates of Fuel Consumption in the Maldivian Pole-and-Line Tuna Fishery. International Pole & Line Foundation, London and Marine Research Centre, Maldives. https://ipnlf.org/wp-content/uploads/2020/11/rates-of-fuel-consumption-in-the-maldives-pole-and-line-tuna-fishery-lr. pdf

robust governance framework. In addition, promoting alternative livelihoods is essential, coupled with knowledge development about these alternatives. Exploration of aquaculture possibilities along with conservation of the sessile species like seagrass meadows- also holds potential.

Medium- to long-term recommendations

Explore a variety of policy options to secure the long-term sustainability of reef and live bait fisheries. This could involve declaring additional MPAs (see Section 3.4) to help replenish depleted fish stocks and preserve ecosystems supporting fisheries. Further strategies might include transitioning to cultured baitfish, optimizing bait use, and implementing rotational zoning284 to ensure sustainable live bait fisheries. Encouraging separate live bait fisheries, as practiced in Japan, could reduce post-harvest mortality.

Enhance monitoring, control, and surveillance efforts to prevent unauthorized fishing. Although Global Fishing Watch data indicates low unauthorized foreign fishing, vigilance is crucial to safeguard Maldivian fish stocks. Increasing patrols and liaising with other governments to prevent unauthorized fishing could strengthen the Maldives' fisheries management. Illegal domestic fishing should also be better understood, such as by expanding surveillance to small unlicensed vessels engaged in reef and recreational fishing.

Consider restructuring the support offered to fishers, such that it allows the sector to remain competitive, while at the same time enabling a profitable value chain development and keeping public fiscal costs at bay. As restructuring the support schemes can significantly impact lower-income households, understanding who is affected is vital, as are opportunities for compensation. Such understanding is also critical for crafting and garnering public support for fiscal reform.[285] Pricing reforms (for fish and fuel) should consider different household groups' impacts, enabling targeted changes that protect the most vulnerable. Cash transfers to low-income households can mitigate subsidy reform impacts and can be conditional, encouraging alternative livelihoods. A comprehensive public communication strategy explaining how fiscal reform aligns with the country's environmental and economic objectives is key for public acceptance.

Develop and implement a knowledge dissemination plan that helps improve the economic and environmental sustainability of reef and live bait fisheries. This plan should include both ongoing and future efforts to raise awareness among live bait fishers. Such efforts might involve improving live bait handling and storage techniques, and raising awareness about alternative species (like milk fish or mullets from aquaculture) as live bait.

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284 i.e., to designate and, and rotate the collection areas of live fish every other year, to allow natural replenishment in the undisturbed areas.

285 Coady, D. , Flamini, V. , & Sears, L. (2015). The Unequal Benefits of Fuel Subsidies Revisited: Evidence for Developing Countries. IMF Working Paper WP/15/250. https://www.imf.org/external/pubs/ft/wp/2015/wp15250. pdf

An estimated 72 percent of the land area lies less than 1.5 meters above mean sea-level, making the Maldives very sensitive to small increases in mean sea levels.

2.3 Coastal protection

2.3.1 Sea level rise in the Maldives

The Maldives is highly vulnerable to global mean sea level rise (SLR) due to its geographical makeup. The nation is composed of small, low-lying islands where people, buildings, and infrastructure are closely intertwined.[286,287] An estimated 72 percent of the land area lies less than 1.5 meters above mean sea-level,[288] making the Maldives very sensitive to small increases in mean sea levels.[289] As SLR progresses, certain areas of the Maldives risk permanent inundation unless significant climate adaptation measures are taken. This issue is notably severe as nearly all its infrastructure and settlements are in these vulnerable, low-lying coastal areas.

Widespread coastal development has reduced the available space between coastline and inland assets and infrastructure, thus amplifying the vulnerability of coastal settlements in the region.

Figure 38. Rapid urbanization has made the Maldives increasingly vulnerable to sea-level rise.

Aerial imagery of Malé and surrounding islands in 1967, 1997, 2010, and 2020

Source: Ali Shareef Ibrahim (2014) (upper images) and Preparing for Rising Seas in the Maldives (nasa.gov) (bottom images).

286 Singh, A. , Pathirana, S. , & Shi, H. (2005). Assessing Coastal Vulnerability Developing A Global Index For Measuring Risk. ResearchGate. https://www.researchgate. net/publication/45072978_Assessing_Coastal_Vulnerability_Developing_A_Global_Index_For_Measuring_Risk

287 NASA Earth Observatory. (n.d.). Preparing for Rising Seas in the Maldives. https://earthobservatory. nasa.gov/images/148158/preparing-for-rising-seas-in-the-maldives

288 Own calculations based on the ground elevation reported in land surveys (n=665) conducted by the Maldives Land & Survey Authority across the entire archipelago between 2011 and 2022.

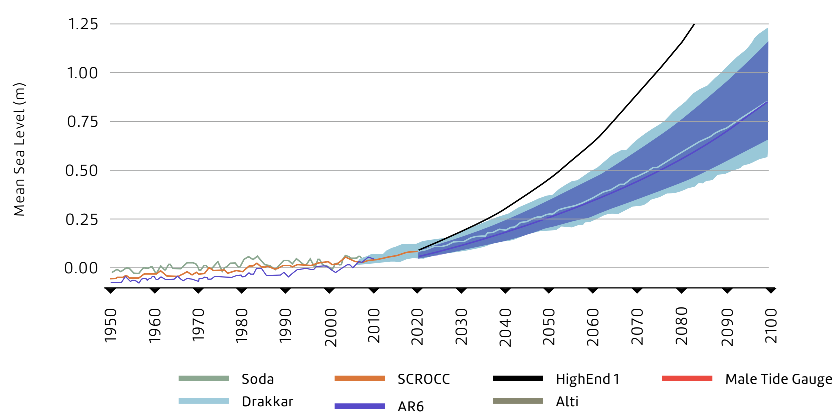
289 IPCC (2019). Chapter 4: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities — Special Report on the Ocean and Cryosphere in a Changing Climate. https://www.ipcc. ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/

Between 1993 and 2015, the mean sea level in the Maldives increased at an annual rate of 3.4 mm.

Rapid urban development on several small islands has compounded the Maldives' vulnerability to coastal threats in two ways. Firstly, a large proportion of the Maldivian population live in coastal zones. This trend is particularly noticeable in the capital city of Malé, which has a population density of 66,000 inhabitants per km², much higher than other Small Island Developing States (SIDS) capitals (for instance, Kiribati's capital only has 3,200 inhabitants per km²). Second, widespread coastal development has reduced the available space between coastline and inland assets and infrastructure, thus amplifying the vulnerability of coastal settlements in the region.[290,291] The country's low elevation compounded by rapid development and urbanization make the Maldives' extremely vulnerable to SLR (see Figure 38).

Figure 39.The mean sea level in the Maldives is projected to increase at an accelerating pace.

Projected sea-levels in the Maldives. Sea-levels relative to the mean of 1995-2014 are shown (in meters).



Source: Amores et al. 2022.

The Maldives has faced mean SLR in the past decades and this trend is projected to continue. Between 1993 and 2015, the mean sea level in the Maldives increased at an annual rate of 3.4 mm.[292] This rate mirrors the global average mean SLR, which was 3.2 mm per year during the same period. Looking forward, the mean sea level in the Maldives is projected to rise by between 0.27 and 0.52 meters by 2050 under a worst-case scenario where global development remains fossil fuel driven (RCP8.5. Baseline period: 1995-2014). This projects an associated SLR rate of between 6 mm and 11.5 mm per year (see figure 39), which is considerably higher than the historically observed rate of 3.4 mm per year.

...there is also a lacking understanding of ocean currents, and sedimentation. These missing pieces make it very hard to give meaningful estimates of what will happen to the different islands by 2050, let alone by 2100.

Understanding the effects of SLR on land areas is a complex undertaking that requires future original analysis. There are several constraints that currently

290 ibid.

291 Arnall, A. (2022). Where land meets sea: Islands, erosion and the thing-power of hard coastal protection structures. Environment and Planning E: Nature and Space, 6(1), 69–86. https://doi.org/10. 1177/25148486221101461

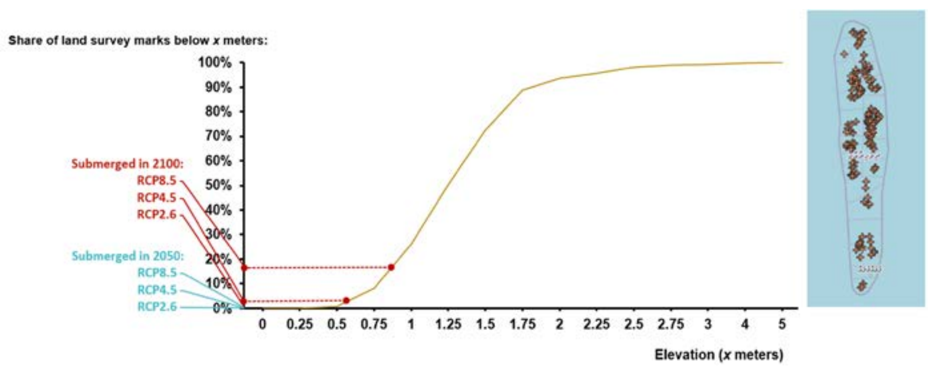
292 Source: World Bank. https://climateknowledgeportal.worldbank.org/country/maldives/impacts-sea-level-rise

Mean SLR is expected to intensify coastal hazards that have already been impacting a large number of resort islands.

thwart obtaining good insights into which areas on the 180+ inhabited islands and 160+ resort islands are going to be submerged because of SLR by 2050 and 2100. To begin with, there is a lack of elevation and relief information, be that under water (bathymetry) or land (topography). In addition, there is also a lacking understanding of ocean currents, and sedimentation. These missing pieces make it very hard to give meaningful estimates of what will happen to the different islands by 2050, let alone by 2100. The CCDR, a sister report to this CEA, is currently prepared and anticipated to be released approximately 6 to 12 months following the CEA. The CCDR will delve deeper into assessing the land areas projected to be submerged due to climate-related factors.

Figure 40. Without any form of adaptation, rising sea-levels can lead to the permanent inundation of some of the Maldives' land area by the end of the 21st century.

Share of land survey marks (y-axis) below a certain threshold (x meters) relative to mean sea-level (assuming no form of adaptation). Submersion analysis based on Amores et al. 2022, Sci. Rep.



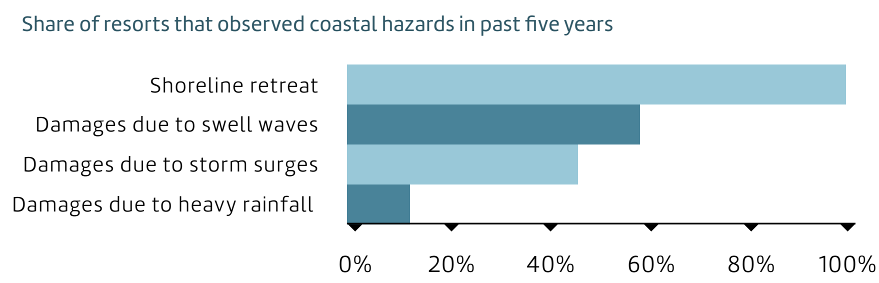
Source: World Bank based on 656 land surveys across the archipelago (including 125 surveys in 43 inhabited islands) between 2011 and 2022 (Maldives Land and Survey Authority (MLSA). [293]

It is noteworthy that all resorts (100%) in the Maldives have reported experiencing the effects of shoreline retreat in the past five years.

In a worst-case scenario (RCP8.5), around one-fifth of the 656 existing georeferenced land survey marks will be submerged by 2100. Depending on the RCP scenario, anywhere from 0 to 3 percent of the currently mapped points will be submerged by 2050, and anywhere from 4 to 18 percent of the currently mapped points will be submerged by 2100. This modeling approach, presented in figure 40, assumes that there are no island formation processes that counteract these effects (see chapter 2.3.2.). Absent continuous geographic elevation information, the analysis of the 656 empirical elevation points is a first approximation of understanding the effects of SLR on land areas in the Maldives. That said, it is important to be mindful of the caveats that such an analysis encompasses (see footnote of figure 40). The CCDR will attempt to provide more detailed insights into the question of what land areas are expected to be submerged in the future, including the presentation of a roadmap for action.

293 Important caveat: Land surveys are typically conducted on the outer edge of islands, where surveyors can find sufficient GPS reception with the aim of providing a point of reference for upcoming construction works (e.g., road, housing, and sanitation projects). Land survey sample covers locations in all atolls (shown in map to the right) except the Gnaviyani atoll.

Figure 41. Virtually all resorts observe significant coastal dynamics, including damages



Source: Environmental and Climate Change Resort Survey (2023), World Bank & Ministry of Tourism, 2023

Rising sea levels mean deeper waters at the shoreline, weakening the wave dissipation function and allowing more wave energy to approach the coastline. This results in larger waves reaching the reef islands.

Mean SLR is expected to intensify coastal hazards that have already been impacting a large number of resort islands. It is noteworthy that all resorts (100%) in the Maldives have reported experiencing the effects of shoreline retreat in the past five years (see Figure 41). In addition, 58 percent and 46 percent have also experienced damages from swell waves and storm surges, respectively. The frequency and severity of these events will likely be exacerbated by the mean SLR. About 12 percent of resorts report issues with heavy rainfall, suggesting that it is a relatively minor problem at this time. Nevertheless, if alterations in weather patterns lead to more intense precipitation events in the future, it's relevance could increase.

Mean SLR will also increase the risk of coastal erosion and flooding in the future because it contributes to stronger waves reaching the coastlines. Mean SLR deepens the water depth above reef flats, which are the shallow portions of the reef platform adjacent to the island surface and act as natural breakwaters by diminishing the wave energy that reaches the shoreline, known as wave dissipating function.[294,295] Typically, the reef crest, being the seaward edge of the reef, reduces the bulk of the wave energy, with the reef flat dissipating the remainder. However, rising sea levels mean deeper waters at the shoreline, weakening the wave dissipation function and allowing more wave energy to approach the coastline. This results in larger waves reaching the reef islands. The Maldives will be particularly affected by these amplified waves. Islands featuring narrower and deeper reef flats will be the earliest to notice a substantial decline in their wave dissipation function, making them more vulnerable to the intensified wave impacts.[296]

294 Beck, M. , Losada, I. J. , Menéndez, P. , Reguero, B. G. , Díaz-Simal, P. , & Fernández, F. (2018). The global flood protection savings provided by coral reefs. Nature Communications, 9(1). https://doi.org/10. 1038/s41467-018-04568-z

295 Ferrario, F. , Beck, M. , Storlazzi, C. D. , Micheli, F. , Shepard, C. C. , & Airoldi, L. (2014). The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. Nature Communications, 5(1). https://doi.org/10. 1038/ncomms4794

296 Storlazzi, C. D. , Gingerich, S. B. , Van Dongeren, A. , Cheriton, O. M. , Swarzenski, P. W. , Quataert, E. , Voss, C. I. , Field, D. R. , Annamalai, H. , Piniak, G. , & McCall, R. B. (2018). Most atolls will be uninhabitable by the mid-21st century because of sea-level rise exacerbating wave-driven flooding. Science Advances, 4(4). https://doi.org/10. 1126/sciadv. aap9741

Extreme sea levels caused at least 30 coastal flood events in the past 50 years in the Maldives (including in Malé).

In addition to the impacts of mean SLR, the Maldives will be increasingly threatened by acute flooding.[297] Flood events are caused by extreme sea-levels that arise due to interactions of mean SLR, astronomical tides, and storm surges (including tropical cyclones). Extreme sea levels caused at least 30 coastal flood events in the past 50 years in the Maldives (including in Malé)[298] as well as beach erosion events.[299] Floods that typically occur once every 100 years lead to an average water height of 67 mm above mean sea level.[300] This water height increase is smaller than the global median increase of 119 mm. However, the low terrain of the Maldives causes it to be more prone to inundation. Many atoll islands will experience extreme water heights that currently happen only once every 100 years on an annual basis by 2050.[301] In much of the Indian Ocean, mean SLR will cause flood frequencies to double by 2050 or sooner.[302] This is because mean sea level represents the baseline water height for storm surges and tides. Likewise, ocean warming is expected to exacerbate the severity of the associated flood events because it increases the incidence of large waves. According to the IPCC, oceans have been on a warming trend since the baseline period 1971-1990, and they are projected to warm further throughout the 21st century.[303] This implies, the Maldives will become increasingly exposed to extreme flood events.

With the projected increase in the intensity of tropical cyclones, the Maldives is expected to face greater instances of extreme sea levels. While the Maldives experiences tropical cyclones infrequently, with only eleven land crossings recorded since 1873.

With the projected increase in the intensity of tropical cyclones, the Maldives is expected to face greater instances of extreme sea levels. While the Maldives experiences tropical cyclones infrequently, with only eleven land crossings recorded since 1873 (see Figure 42), their impact can be profound.[304] The number of tropical cyclones crossing the Maldives is lower than in other countries bordering the Indian Ocean because cyclones do not typically form near the equator.[305] Nevertheless, tropical cyclones can cause considerable damage in the Maldives; in 2021, a tropical cyclone affected an estimated 1,320 people in the Maldives.[306] The projected accelerated warming of the

297 Amores, A. , Marcos, M. , Pedreros, R. , Cozannet, G. L. , Lecacheux, S. , Rohmer, J. , Hinkel, J. , Gussmann, G. , Van Der Pol, T. , Shareef, A. , & Khaleel, Z. (2021). Coastal Flooding in the Maldives Induced by Mean Sea-Level Rise and Wind-Waves: From Global to Local Coastal Modelling. Frontiers in Marine Science, 8. https://doi.org/10. 3389/fmars. 2021. 665672

298 Wadey, M. P. , Brown, S. , Nicholls, R. J. , & Haigh, I. D. (2017). Coastal flooding in the Maldives: an assessment of historic events and their implications. Natural Hazards, 89(1), 131-159. https://doi.org/10. 1007/s11069-017-2957-5

299 Zalif, Z. (2022). Swell waves cause flooding in carnival region. https://raajje.mv/126079

300 Muis, S. , Verlaan, M. , Bierkens, M. F. P. , Aerts, J. C. J. H. , & Ward, P. B. (2016). A global reanalysis of storm surges and extreme sea levels. Nature Communications, 7(1). https://doi.org/10. 1038/ncomms11969

301 IPCC (2019). Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate

302 IPCC (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability. https://www.ipcc. ch/report/ar6/wg2/

303 IPCC (2019). Chapter 4: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities — Special Report on the Ocean and Cryosphere in a Changing Climate. https://www.ipcc. ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/

304 Muis, S. , Verlaan, M. , Bierkens, M. F. P. , Aerts, J. C. J. H. , & Ward, P. B. (2016b). A global reanalysis of storm surges and extreme sea levels. Nature Communications, 7(1). https://doi.org/10. 1038/ncomms11969

305 NOAA. (n.d.). JetStream. https://www.weather.gov/jetstream/tc#:~:text=However%2C%20with%20only%20the%20rarest,causes%20the%20cyclone%20to%20spin.

306 EM-DAT (n.d.). The international disasters database. https://www.emdat. be/

The natural adaptability of coral reef islands counteracts the impacts of sea level rise. Coral reef islands are dynamic, and they change with continuous supply of sediment (sand) that is being produced by coral reefs.

Indian Ocean is likely to increase the severity of such tropical cyclones.[307,308,309] Consequently, despite their infrequency, more potent tropical cyclones could lead to increased damages in the future.

Figure 42. Tropical cyclones are rare in the Maldives

Tropical cyclone tracks since 1873

Source: NOAA (2023). International Best Track Archive for Climate Stewardship (IBTrACS) | National Centers for Environmental Information (NCEI) (noaa.gov).

2.3.2 Natural adaptation to sea level rise

The natural adaptability of coral reef islands counteracts the impacts of sea level rise. Coral reef islands are dynamic, and they change with continuous supply of sediment (sand) that is being produced by coral reefs. This sediment is gradually deposited onto the islands' surfaces by waves, leading to an increase in the elevation of low-lying islands, a process known as island-building.[310] Coral reef islands are composed of the sediment that is predominantly produced by coral reefs. The main question is whether this island-building mechanism will be able to outpace future SLR, like it has done in the past.

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307 Panickal, S. , Puthiyadath, S. , Narayanasetti, S. , & Jadhav, J. (2022). Increasing Frequency of Extremely Severe Cyclonic Storms in the North Indian Ocean by Anthropogenic Warming and Southwest Monsoon Weakening. Geophysical Research Letters, 49(3). https://doi.org/10. 1029/2021gl094650

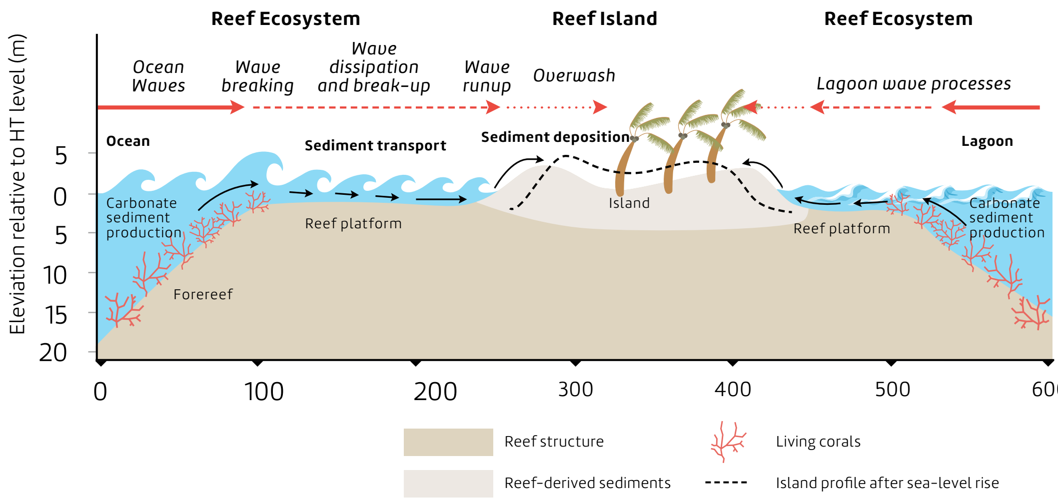
308 IPCC (2019). Chapter 4: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities — Special Report on the Ocean and Cryosphere in a Changing Climate. https://www.ipcc. ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/

309 Wang, G. , Wu, L. , Mei, W. , & Xie, S. (2022). Ocean currents show global intensification of weak tropical cyclones. Nature, 611(7936), 496–500. https://doi.org/10. 1038/s41586-022-05326-4

310 Masselink, G. , Beetham, E. , & Kench, P. S. (2020). Coral reef islands can accrete vertically in response to sea level rise. Science Advances, 6(24). https://doi.org/10. 1126/sciadv. aay3656

Figure 43. Corals and algae provide sediments for island building

Sedimentation production, transport, and deposition near reef islands



Source: World Bank, adapted from Gerd Masselink and Jamie Quinn.

As waves become higher due to rising sea levels, more sediment is deposited onto the islands, raising their elevation. This dynamic means coral reef islands are much less affected than static models indicate, as the sediments to the island surface help maintain elevation above sea level even in the face of rising sea levels. This process, however, is contingent upon the presence of healthy, growing reefs that positively contribute to sediment production and island elevation maintenance, rather than eroding reefs which do not provide such support. A visual representation of reef island building under different levels of sea level rise is provided in Figure 43. With higher levels of SLR, the island crest, the highest point of the island edge, moves landward and becomes higher. Therefore, when evaluating the relationship between SLR and the permanent inundation of coral reef islands, this adaptive aspect should be taken into account.

In the distant past, Maldivian reef islands were able to adapt to SLR that was similar in magnitude to that projected for the 21st century. Typically, climate change-associated SLR is considered over several centuries. However, when examining the further past, it's clear that the rate of SLR was once much higher than today. The massive melting of ice-sheets at the end of the last ice age, around 15,000 years ago, caused SLR of up to 18 meters in the 500 years that followed.311 In the thousands of years after that, cumulative SLR exceeded 100 meters.[312] Sea levels reached a maximum between 4,000 and

311 Durham University. (n.d.). Melting ice sheets caused sea levels to rise up to 18 metres. https://www.dur. ac. uk/environmental. sustainability/news/?itemno=44283

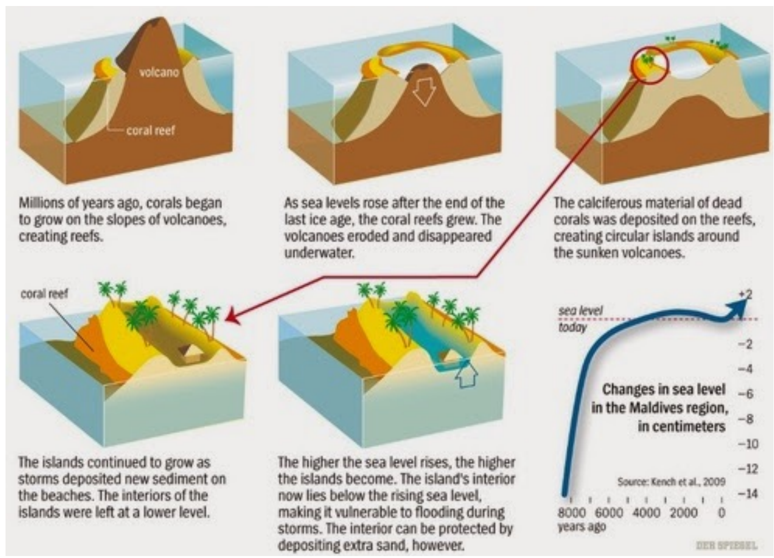
312 CSIRO. (2018). Sea Level, Waves and Coastal Extremes. https://research. csiro. au/slrwavescoast/

The capacity of coral reef islands to naturally adapt to rising sea levels is largely contingent on the health of their associated coral reefs. Coral reefs, with their incredibly diverse ecosystems, play a significant role in providing sediment for the creation and nourishment of these islands.

2,100 years before present, when the sea level in the Maldives was at least 0.5 meters above the present level.[313] Importantly, Maldivian islands were able to form during this time period through the accumulation of sediment on top of reef flats. Higher sea levels induced vertical island-building by enhancing the deposition of sediment on the reef platform and island surface (see Figure 44). If future SLR reactivates this sedimentation process, coral reef islands may be able to keep up with future SLR throughout the 21st century. Much more clarity on this foundational question is needed.

Figure 44. Maldivian reef islands were able to form under sea-level rise.

How Maldivian atolls were created and continued to exist in function of sea-level rise.



Source: Der Spiegel based on Kench et al. 2009

The capacity of coral reef islands to naturally adapt to rising sea levels is largely contingent on the health of their associated coral reefs. Coral reefs, with their incredibly diverse ecosystems, play a significant role in providing sediment for the creation and nourishment of these islands. Three organism groups, namely corals, algae, and parrotfish, are particularly instrumental in this process. Corals are composed of a multitude of tiny organisms known as polyps, while algae reside within the coral tissues. Together, these entities are responsible for the generation of sediment that contributes to the construction of reef islands. For several Maldivian islands, the sediment derived from corals and algae makes up approximately 59% and 25% of the island surface sediment, respectively.[314]

313 East, H. K. , Perry, C. T. , Kench, P. S. , Liang, Y. F. , & Gulliver, P. (2018). Coral Reef Island Initiation and Development Under Higher Than Present Sea Levels. Geophysical Research Letters, 45(20). https://doi.org/10. 1029/2018gl079589

314 Perry, C. T. , Kench, P. S. , O'Leary, M. J. , Morgan, K. , & Januchowski-Hartley, F. A. (2015b). Linking reef ecology to island building: Parrotfish identified as major producers of island-building sediment in the Maldives. Geology, 43(6), 503–506. https://doi.org/10. 1130/g36623. 1

Various external factors, such as ocean acidification and warming, negatively impact coral reef health and impede this form of natural adaptation.

Parrotfish contribute to the sand formation process by eating the corals and algae and excreting indigestible calcium carbonate as sand, which waves then transport onto the island surfaces. It is estimated that more than 85% of coral sand in Maldivian reefs can be attributed to parrotfish grazing. Thus, the existence of healthy coral reefs is integral to the island-building process.[315,316]

The vulnerability of the Maldives to SLR depends critically on the health of coral reefs.[317,318,319] Various external factors, such as ocean acidification and warming, negatively impact coral reef health and impede this form of natural adaptation. Consequently, monitoring the effects of climate change on coral reefs becomes crucial as they serve as indicators of the Maldivian reef islands' coastal resilience. Moreover, human activities, including construction, dredging, and fishing, should be regulated to limit their damaging impacts on coral reef health. Such restrictions are indispensable for promoting vertical island-building in response to SLR.

Maintaining healthy corals is not just an indicator of coral reef health but also a critical factor determining the coastal protection services provided by coral reefs.

The presence of live corals on reef surfaces is a critical determinant of coastal protection.[320,321] The existence of live corals on reef surfaces is crucial for coastal protection. Coral reefs, with their myriad of animal and plant species, create a highly uneven surface on the seafloor. This roughness significantly influences the propagation of waves and currents over the reef flats, with rougher seafloors causing more friction for incoming waves, thereby reducing the amount of wave energy reaching the island shorelines. As the primary builders of the reef structure, live corals have the most significant impact on seafloor roughness.[322] Furthermore, the extent of reef flats covered with live corals is a key determinant of the coastal protection services provided by coral reefs. As live corals grow, they occupy space in the water column, effectively reducing the water depth over reef flats. Wave energy in nearshore environments is directly proportional to water depth; live corals further diminish the waves reaching the reef islands by limiting water depths. In contrast, when corals die, reef crests tend to become more rounded due to erosion, causing the coral structures to gradually vanish from the reef surface.

315 Yarlett, R. T. , Perry, C. T. , & Wilson, R. W. (2021). Quantifying production rates and size fractions of parrotfish- derived sediment: A key functional role on Maldivian coral reefs. Ecology and Evolution, 11(22), 16250–16265. https://doi.org/10. 1002/ece3. 8306

316 Perry et al. (2015). Linking reef ecology to island building: Parrotfish identified as major producers of island-building sediment in the Maldives. Geology 43, 6, 503-506.

317 Masselink et al. (2020). Coral reef islands can accrete vertically in response to sea level rise. Sci. Adv.; 6 : eaay3656

318 Costa, M. B. S. F. , Macedo, E. C. D. , & Siegle, E. (2019). Wave refraction and reef island stability under rising sea level. Global and Planetary Change, 172, 256–267. https://doi.org/10. 1016/j. gloplacha. 2018. 10. 015

319 Tuck, M. E. , Ford, Masselink, G. , & Kench, P. S. (2019). Physical modeling of reef island topographic response to rising sea levels. Geomorphology, 345, 106833. https://doi.org/10. 1016/j. geomorph. 2019. 106833

320 Ferrario, F. , Beck, M. , Storlazzi, C. D. , Micheli, F. , Shepard, C. C. , & Airoldi, L. (2014). The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. Nature Communications, 5(1). https://doi.org/10. 1038/ncomms4794

321 Alvarez-Filip, L. , Dulvy, N. K. , Gill, J. A. , Côté, I. M. , & Watkinson, A. R. (2009). Flattening of Caribbean coral reefs: region-wide declines in architectural complexity. Proceedings of the Royal Society B: Biological Sciences, 276(1669), 3019–3025. https://doi. org/10. 1098/rspb. 2009. 0339

322 Sheppard, C. , Dixon, D. A. , Gourlay, M. R. , Sheppard, A. , & Payet, R. (2005). Coral mortality increases wave energy reaching shores protected by reef flats: Examples from the Seychelles. Estuarine Coastal and Shelf Science, 64(2–3), 223–234. https://doi.org/10. 1016/j. ecss. 2005. 02. 016

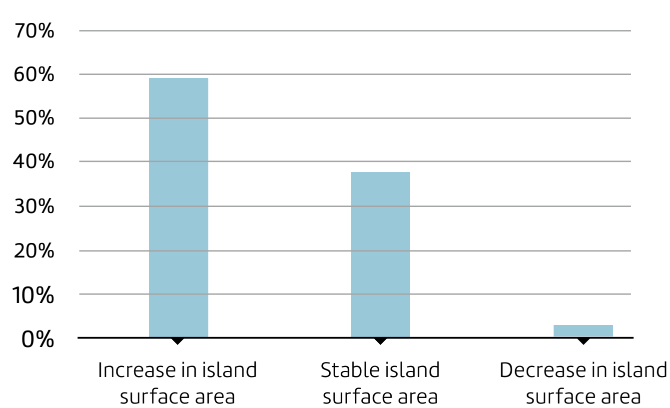
Coastal erosion remains a significant concern in the Maldives and necessitates a proactive and systematic approach to mitigate its impacts.

As reef crests play a pivotal role in wave attenuation, coral mortality is harmful to their coastal protection contribution. Overall, maintaining healthy corals is not just an indicator of coral reef health but also a critical factor determining the coastal protection services provided by coral reefs.

Coastal erosion is widely observed across the Maldivian islands, yet very few Maldivian inhabited islands experienced net land losses. Despite historical data indicating that most Maldivian inhabited islands have not undergone net land loss, the widespread occurrence of coastal erosion cannot be overlooked. The coastal erosion that has been observed in most islands has been counteracted by accretion elsewhere on the islands, leading to either net stability or next gains for most islands. According to a 2004 survey, approximately 97 percent of the Maldivian islands experienced coastal erosion.[323] Yet, despite historically observed SLR, only 3 percent of Maldivian islands witnessed a net land loss between 2004 and 2016 (see Figure 45). In contrast, a majority of the islands—59 percent—recorded an increase in land area. On average, the change in area is +23 percent (7.7 hectares). This, in many instances, is a result of strategic land reclamation initiatives and the natural accumulation of sediments from coral reefs, which contribute to the vertical growth of the islands. Therefore, it is crucial to underscore that coastal erosion remains a significant concern in the Maldives and necessitates a proactive and systematic approach to mitigate its impacts. Infrastructure development and planning must be forward-thinking, considering the dynamic nature of coastlines and considering the potential downstream effects. For existing structures, there is a proactive need to identify and mitigate risks.

Figure 45. Only 3 percent of Maldivian islands experienced net land loss between 2004 and 2016

Fraction of islands experiencing increasing, stable or decreasing land surface area between 2014 and 2016.



Source: Amores et al. 2022.

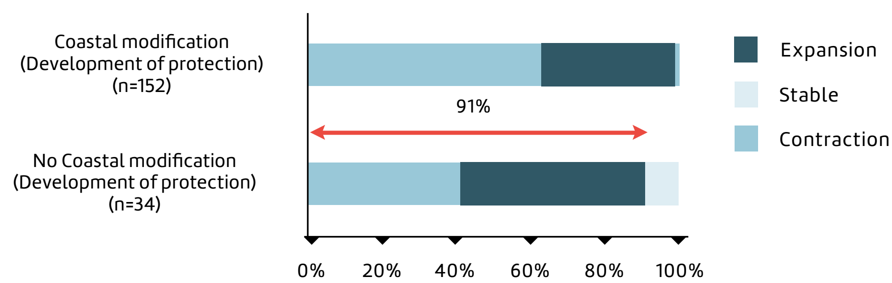
323 UNFCCC NAPA Maldives. UNFCCC NAPA Maldives

The Government of Maldives has made the development of coastal infrastructure a key strategic priority. Port, harbor, dredging, and land reclamation projects worth US$ 610 million were funded between 2013 and 2021 alone.

The stability of Maldivian islands is likely to come from coral reef ecosystems. Not only islands where substantial coastal modification occurred (such as port development and revetment construction) remained stable or expanded in surface area, but also islands without coastal modification. 91 percent of the islands that did nothing in terms of coastal development and protection remained stable or expanded in surface area between 2004 and 2016 (see Figure 46). This finding suggests that island stability may have been the result of ecosystem adaptation to SLR (4 mm per year between 2004 and 2016) rather than coastal modification. It should be noted, however, that especially islands most at risk of island contraction received support for coastal protection from the central government.

Figure 46. Many islands without coastal modification remained stable or expanded in surface area

Share of islands that expanded, remained stable, or contracted. Shares of islands with and without coastal modification are shown



Source: World Bank based on Duvat 2020.

2.3.3 Coastal Development hampers Reef Island Adaptation

Coastal development, including land reclamation and port and harbor construction, has been an important pillar of the economic development strategy of the Maldives. Coastal development is a necessary condition for meeting the development needs of an expanding population. Port infrastructure is critical to the Maldivian economy because it facilitates international trade in fisheries products and the movement of people within the Maldives and beyond. Accordingly, the GoM has made the development of coastal infrastructure a key strategic priority.[324] Port, harbor, dredging, and land reclamation projects worth US$ 610 million were funded between 2013 and 2021 alone (2021 dollars).[325] This brings the average annual expenditure on coastal development to 4 percent of public expenditure during this period. As a result of this development strategy, virtually all inhabited islands now

324 Government of Maldives. (2019). Strategic Action Plan 2019-2023. https://storage. googleapis.com/presidency.gov.mv/Documents/SAP2019-2023.pdf

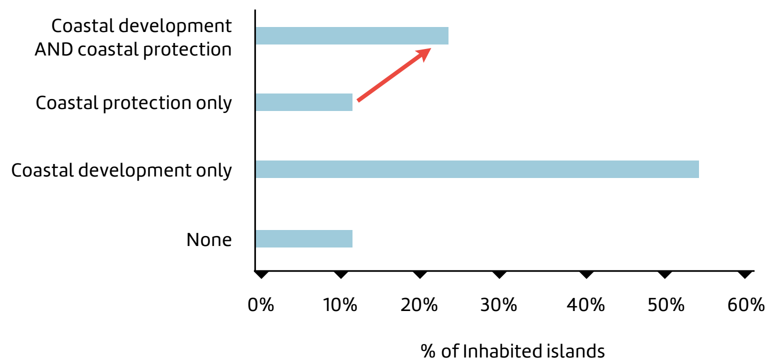
325 Budget in Statistics. (2023). Ministry of Finance. https://www.finance.gov.mv/budget-in-statistics

Many coastal development projects negatively affect the services provided by coral reefs. Furthermore, coastal development increases the need for coastal protection measures.

have a harbor; four major ports/terminals were developed or upgraded since 2005, and there are several port projects in the pipeline (including Gulhifalhu International Port, Addu International Port, and Ihavandhippolhu Transshipment Port).

Figure 47. Inhabited islands that implemented coastal development projects between 2004 and 2016 were twice as likely to implement coastal protection measures

Share of islands that implemented coastal development and coastal protection measures.



Source: World Bank based on Duvat 2020.

Inhabited islands where coastal development (harbors, dredging, land reclamation, quay, and jetties) were implemented have had twice as much coastal protection investments than inhabited islands without coastal development.

Coastal development is increasing in the Maldives while having serious negative effects on coastal ecosystems and coastlines. Between 2000 and 2016 alone, over 10 km2 of coastal ecosystems have been affected by dredging and land reclamation.[326] The upward trend in the annual number of development projects seeking Environmental Clearance from the EPA shows that coastal development is accelerating (see Section 4.3). Many coastal development projects negatively affect the services provided by coral reefs (see Figure 47). Furthermore, coastal development increases the need for coastal protection measures. This is because coastline modification disrupts local sediment transport processes, leading to substantial down-drift coastal erosion. As an example, Figure 47 shows how the construction of a port in Gan island led to a ~50 meters coastline displacement on the east side of the port. The construction of another seaport on the east coast of Fuvahmalah island also resulted in considerable coastal erosion along the shoreline of the island.[327,328] Hence, the widespread construction of ports and harbors can be expected to bring with it coastal erosion issues across the archipelago. A comparison of coastal modifications in inhabited islands provides evidence of this mechanism. Specifically, inhabited islands where coastal development (harbors, dredging, land reclamation, quay, and jetties) were implemented have had twice as

326 CBD Strategy and Action Plan 2016-2025. https://www.cbd. int/doc/world/mv/mv-nbsap-v2-en.pdf

327 David, C. G. , Hennig, A. , Ratter, B. M. W. , Roeber, V. , Zahid, & Schlurmann, T. (2021). Considering socio-political framings when analyzing coastal climate change effects can prevent maldevelopment on small islands. Nature Communications, 12(1). https://doi.org/10. 1038/s41467-021-26082-5

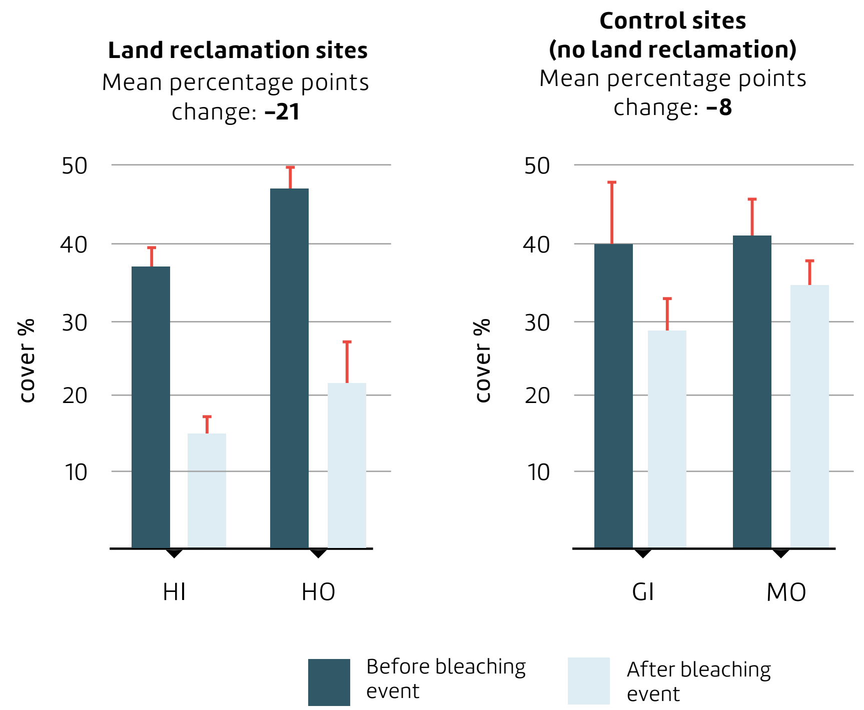
328 Fund, G. C. (n.d.). FP165: Building Climate Resilient Safer Islands in the Maldives. Green Climate Fund. https://www.greenclimate.fund/project/fp165

Coral mortality due to the 2016 ocean temperature hike was 13 percent higher in coral reefs near land reclamation sites compared to coral reefs in areas without land reclamation activities

much coastal protection investments than inhabited islands without coastal development. This proportion is indicative of the increasing coastal protection needs in the wake of coastal infrastructure development. The need for additional coastal protection investments represents a substantial external cost that should be considered in development planning.

Figure 48. The negative impact of ocean temperature hikes on coral reef health is stronger near land reclamation areas.

Coral mortality due to temperature increase (that caused 2016 bleaching event) near land reclamation in Himmafushi island (left) and control sites (right).



Source: Adapted from Pancrazi et al. 2020

Furthermore, coastal developments, such as dredging and land reclamation, exacerbate coral mortality in nearby reefs during bleaching events. Coral mortality due to the 2016 ocean temperature hike was 13 percent higher in coral reefs near land reclamation sites compared to coral reefs in areas without land reclamation activities (see Figure 48). This is because the sediment that is generated during land reclamation activities reduces the resilience of nearby corals. Land reclamation projects also make corals more vulnerable to ocean warming by reducing the size of coral populations.[329]

329 Cornwall, C. E., Comeau, S., Kornder, N. A., Perry, C. T., Van Hooidonk, R., DeCarlo, T. M., Pratchett, M. S., Anderson, K. G., Browne, N. K., Carpenter, R. J., Diaz-Pulido, G., D'Olivo, J. C., Doo, S. S., Figueiredo, J., Fortunato, S. a. V., Kennedy, E. V., Lantz, C. A., McCulloch, M. T., González-Rivero, M., . . . Lowe, R. J. (2021). Global declines in coral reef calcium carbonate production under ocean acidification and warming. Proceedings of the National Academy of Sciences of the United States of America, 118(21). https://doi.org/10. 1073/pnas. 2015265118

Box 8. Tracking coastline changes in Gulhi island with satellite imagery

Understanding how coastlines evolve over time due to coastal developments is an important component of coastal vulnerability assessments. A case in point is Gulhi island, where coastal development about 15 years ago led to significant coastal erosion.

An analysis of satellite imagery in 2003 and 2022 shows where land was gained and lost. Port development and beach reclamation projects led to land gains that outstripped land losses by far. However, a revetment solution was implemented to mitigate erosion caused by the harbor construction. The Gulhi island council is now looking for additional coastal protection and land expansion solutions in areas affected by coastal erosion.

Sand mining for land reclamation and building construction demands critical attention due to its far-reaching consequences on sediment budgets and erosion rates across the islands.

Dredging and port development projects will continue to adversely affect coral reef integrity across the entire archipelago. Within the proposed budget for the years 2023, 2024, and 2025 alone, the GoM earmarked the equivalent of US$ 372 million for port/harbor development and dredging projects.[330] This amount equals 7.5 percent of the total proposed government budget for these years. The spatial distribution of port infrastructure and dredging projects is presented in Figure 49 below. Several large projects make up a considerable share of the total budget, including the Gulhifalhu Dredging and Reclamation project (US$ 232 million) and the Fuvahmulah coastal protection project (US$ 42 million). The spatial distribution of these projects suggests that concerns regarding the negative impacts on coral reef integrity is a matter of national concern.

Sand mining for land reclamation and building construction demands critical attention due to its far-reaching consequences on sediment budgets and erosion rates across the islands. Dredging, a primary method for sand extraction, profoundly alters the seafloor's topography, disrupting the natural sediment transport. This disruption leads to erosion in certain areas, while causing sediment accumulation in others. The increased erosion from dredging endangers Maldives' coral reefs—vital for protection, biodiversity, and tourism—and impacts its crucial fisheries and tourism industries. The EPA has recognized these challenges, issuing warnings against unauthorized sand

330 Ministry of Finance. (n.d.). https://www.finance.gov.mv/

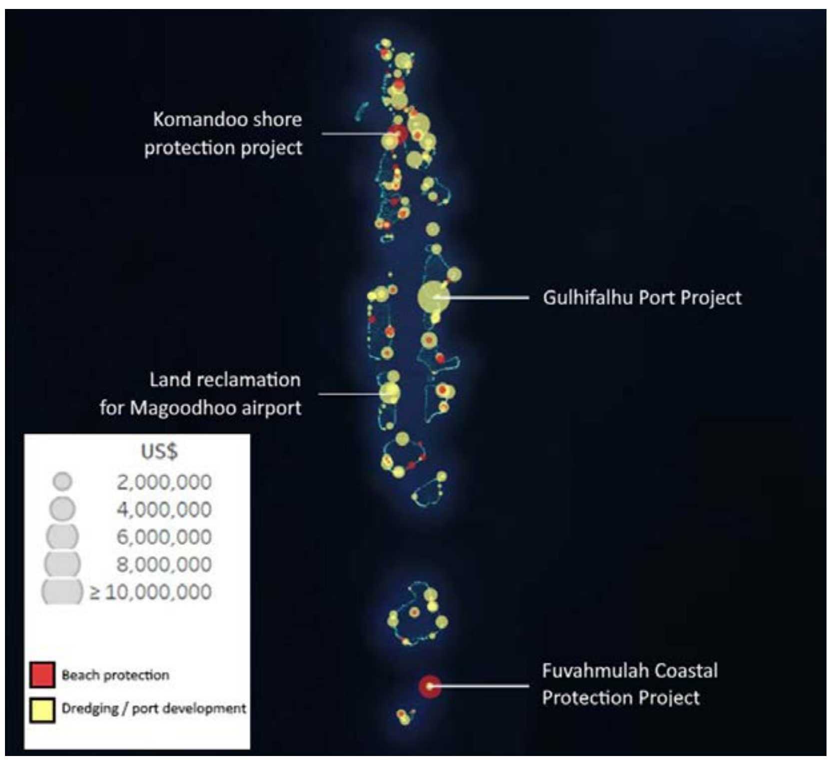
The increasing need for coastal protection brings along a significant cost burden for resort owners. Currently, coastal protection measures, such as sandbags, breakwaters, and beach nourishment, already cost most resorts at least US$10,000 per year.

extraction and emphasizing the importance of adhering to regulations.[331] Their concerns are not unfounded. A 2022 land reclamation project approved by the Maldivian president on Addu atoll, which involves dredging a staggering seven million cubic meters of sand, has been flagged for its potential "significant irreversible damages" to marine ecosystems.[332] While the local community anticipates economic and housing benefits from such projects, the long-term environmental and economic repercussions, such as climate vulnerability or potential losses for diving operators and the fishing industry, cannot be ignored.

The increasing need for coastal protection brings along a significant cost burden for resort owners. Currently, coastal protection measures, such as sandbags, breakwaters, and beach nourishment, already cost most resorts at least US$10,000 per year (see Figure 50). The increasing exposure to coastal hazards in the future, possibly compounded by down-drift impacts of coastal development, will increase these costs.

Figure 49. Coastal development projects are planned across the entire archipelago

Dredging and port development projects (yellow) and beach protection projects (red) in the 2023-2025 government budget.



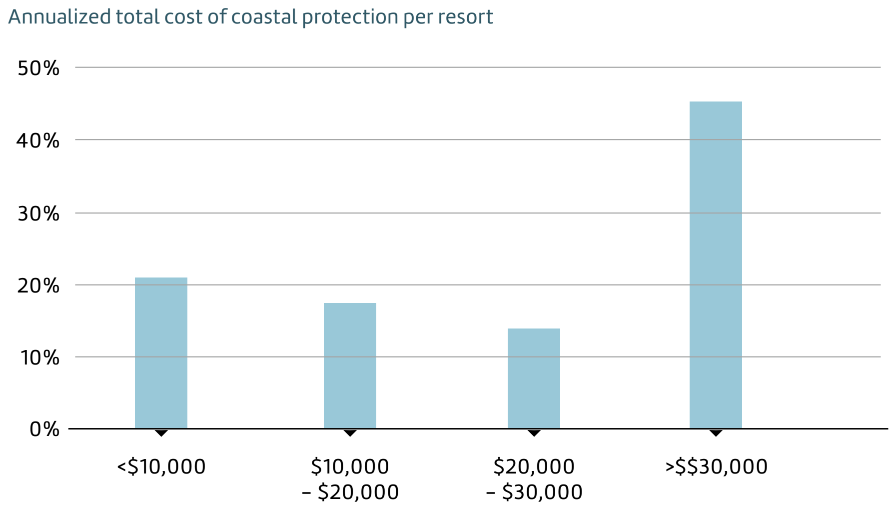
Source: World Bank, based on Ministry of Finance

331 Sun (2022) EPA: Will take action for taking sand from beaches https://en.sun.mv/73824

332 Climate Home News (2022) https://www.climatechangenews.com/2022/03/25/maldives-greenlights-destructive-dredging-to-build-housing-and-luxury-resorts/

The archipelagic nature of the Maldives requires that adaptation strategies are determined on an island-by-island basis within a national planning framework. In this way, adaptation action for the most vulnerable islands can be prioritized.

Figure 50. The cost of coastal protection exceeds $30,000 per year in almost half of the resort islands (45%)



Source: World Bank & Ministry of Tourism led Environment and Climate Survey of Resort Islands (2023).

The seawall is the most used defense strategy in the Maldives but breakwaters and groins are also common. Seawalls are effective in protecting harbors and beaches, and are widespread across the Maldives.

2.3.4 Coastal adaptation Measures– Nature-Based and Gray Solutions

The Maldives can adopt several different strategies to deal with the adverse impacts of climate change on sea level rise and flooding: 1) do nothing, 2) accommodate, 3) defend, 4) advance (including creating new islands),[333] and 5) retreat.[334] So far, the Maldives has been actively defending its existing islands with hard engineering infrastructure as well as creating new land through extensive land reclamation (coastal advance). The archipelagic nature of the Maldives requires that adaptation strategies are determined on an island-by-island basis within a national planning framework. In this way, adaptation action for the most vulnerable islands can be prioritized. The optimal strategy may differ between islands, depending on, for example, the presence of critical infrastructure, population density, and the natural ability of islands to adapt to sea level rise.

Many islands in the Maldives have chosen to follow the defend and/or advance strategies (see Figure 51). The defense strategy ensures that the current location of shorelines is maintained while minimizing the impacts of coastal erosion and floods. The seawall is the most used defense strategy in the Maldives but breakwaters and groins are also common. Seawalls are effective in protecting harbors and beaches, and are widespread across the Maldives partly because they are often perceived as the only option when

333 Miller, N. (2022, February 25). A new island of hope rising from the Indian Ocean. BBC Travel. https://www.bbc.com/travel/article/20200909-a-new-island-of-hope-rising-from-the-indian-ocean

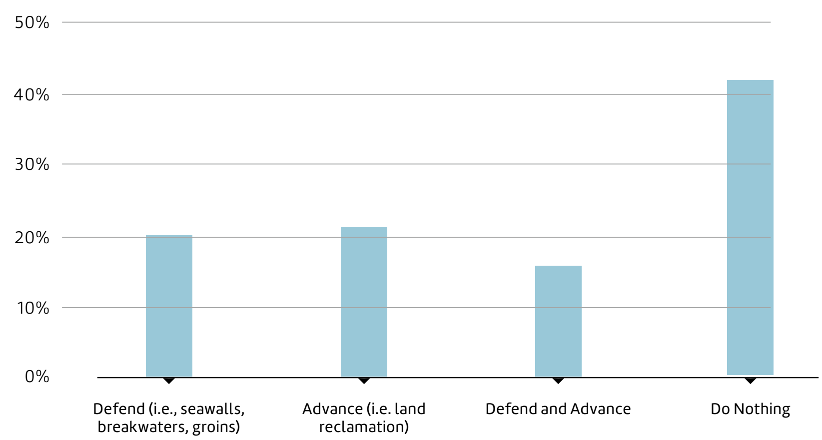
334 IPCC (2019). Chapter 4: Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities — Special Report on the Ocean and Cryosphere in a Changing Climate. https://www.ipcc. ch/srocc/chapter/chapter-4-sea-level-rise-and-implications-for-low-lying-islands-coasts-and-communities/

Historically, there has been a clear preference for hard adaptation measures in the Maldives, the first being implemented as early as the 1970s. Today, gray solutions remain the intervention of choice for inhabited and resort islands alike, likely due to a perception of higher safety and longevity.

space is limited and urgent adaptation action is needed.[335] A similar fraction of islands created new land area through extensive land reclamation, and a relatively smaller fraction of islands followed a combined coastal defense and advance strategy.

Figure 51. Many inhabited islands have chosen to defend and/or advance their coastal areas

Share of islands choosing coastal adaptation strategies between 2004 and 2016.



Source: World Bank based on Duvat (2020)

Nature-Based Solutions (NbS) is an umbrella term for activities aimed at restoring and enhancing natural ecosystem services to support societal challenges, simultaneously benefiting people and nature. Societal challenges that are particularly pressing in island nations like the Maldives include adaptation to the consequences of climate change (e.g., sea level rise, more frequent storms, sea surges), food security, and water management. NbS can address these challenges through activities such as ecosystem restoration, rehabilitation, improved management, and conservation. A well-known form of NbS in the Maldives is Heyhli, which refers to coastal vegetation (e.g., mangroves, palms, coastal shrubs) that acts as a buffer against climate hazards.

Gray measures have been viewed as the go-to solution in the Maldives rather than NbS. Gray solutions, sometimes called "hard" solutions, refer to man-made engineering solutions, including land reclamation, seawalls, groins, and quay walls. Historically, there has been a clear preference for hard adaptation measures in the Maldives, the first being implemented as early as the 1970s. Today, gray solutions remain the intervention of choice for inhabited and resort islands alike,[336] likely due to a perception of higher safety and longevity.[337]

335 UNDP. (2019). Survey of Climate Change Adaptation Measures in Maldives. https://www.undp.org/maldives/publications/survey-climate-change-adaptation-measures-maldives

336 ibid.

337 Sovacool, B. K. (2011). Perceptions of climate change risks and resilient island planning in the Maldives. Mitigation and Adaptation Strategies for Global Change, 17(7), 731-752. https://doi.org/10. 1007/s11027-011-9341-7

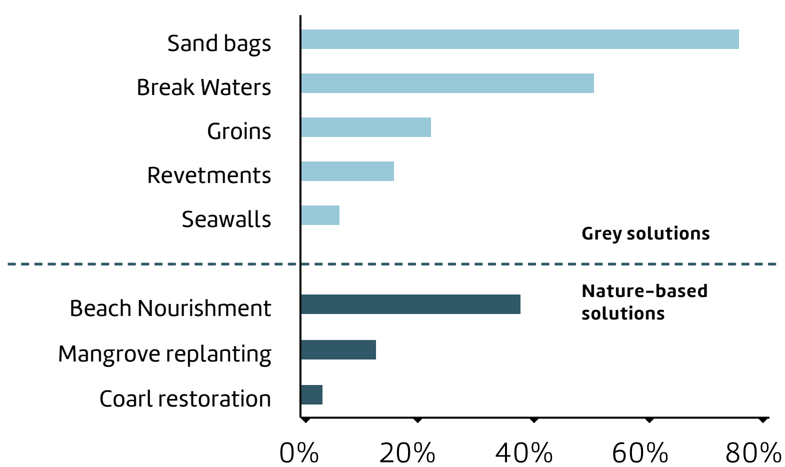
Between 2004 and 2016, hard engineering solutions were implemented on 45 islands, while Nature Based Solutions (beach nourishment) were implemented on only two islands.

For example, between 2004 and 2016, hard engineering solutions were implemented on 45 islands, while NBS (namely beach nourishment) were implemented on only two islands.[338] Furthermore, many resort islands used sandbags (75%) and breakwaters (50%) to improve coastal safety in the past five years, whereas the implementation of NBS, such as mangrove restoration and coral restoration, was very limited (less than 12%) (see Figure 52).

Photo Description: Concrete coastal protection around the Male City © World Bank

Figure 52. Resort islands prefer grey solutions rather than nature-based solutions

Share of resorts that implemented grey and nature-based coastal protection solutions in the past five years.



Source: World Bank & Ministry of Tourism led Environment and Climate Survey of Resort Islands (2023).

338 Duvat, V. (2020). Human-driven atoll island expansion in the Maldives. Anthropocene, 32, 100265. https://doi.org/10. 1016/j. ancene. 2020. 100265

The health of coral reefs is increasingly recognized as a fundamental pillar of the provision of sand sediments to coasts and ultimately coastal protection…

The implementation of NbS for adaptation in the Maldives has been sparse and poorly documented.[339] However, several initiatives reflect increasing awareness of the potential of NBS for coastal protection and other services (see Section 2.3.4) at national scale (see Table 6). The health of coral reefs is increasingly recognized as a fundamental pillar of the provision of sand sediments to coasts and ultimately coastal protection, including in the currently on-going Green Climate Fund project ("Building Climate Resilient Safer Islands in Maldives"). While more focused on biodiversity than coastal protection, the GoM has also extended conservation status to 9 sites that host mangroves,[340] and there is attention for reef restoration needs under the national coral reef restoration and rehabilitation program. NbS with a direct focus on coastal adaptation involving mangroves and seagrasses remain absent in the Maldives.

Table 6. Summary of governmental implementation of Nature Based Solutions

			Purposes	Maldives implementation
Climate change adaptation	**Reefs**	Reef Restoration	• Coastal protection (on crests and flat reefs) (wave mitigation, erosion reduction, flooding control, sediment accretion, coastal stabilization) • Biodiversity-food security • Aquaculture (gates with farmed species (fish, clams, lobster, pearls, oysters) mounted on the top of protective hard infrastructures)	Y National Coral Reef Restoration and Rehabilitation Program (MMRI)
		Hybrid engineering and NBS (Artificial structures over reefs)		N
	Lagoon	Mangrove conservation	• Coastal protection (avoided subsidence, sediment accretion, reduced erosion) • Reduced saline intrusion in soils and aquifers • Aquaculture (mangrove/seagrass)-food security	Mangrove conservation in 9 protected areas
		Mangrove restoration		N
		Mangrove planting		N
		Seagrass planting		N
	Land	Littoral revegetation (palms, shrubs)	• Coastal stabilization	N
		Mangrove restoration	• Coastal protection (avoided subsidence, sediment accretion, reduced erosion) • Reduced saline intrusion in soils and aquifers • Aquaculture (mangrove/seagrass)-food security	N
		Beach nourishment	• Coastal stabilization	Y (GCF project with JICA support) 2021-2024
Climate change Mitigation	**Land**	Mangroves restoration	• Emission removals	N
		Mangrove reforestation		N
	Ocean	Seagrass restoration		N
		Seagrass planting		N

339 Webber, M. , Jarillo, S. , Swearer, S. E. , Lovelock, C. E. , Pomeroy, A. , Konlechner, T. M. , Waters, E. , Morris, R. J. , & Lowe, R. J. (2022). Nature-based solutions for atoll habitability. Philosophical Transactions of the Royal Society B, 377(1854). https://doi.org/10. 1098/rstb. 2021. 0124

340 Environmental Protection Agency. (n.d.). EPA. https://en. epa.gov.mv/regulations

... soft adaptation avoids the visual disruption associated with hard adaptation infrastructure like concrete seawalls, which is particularly relevant for resort islands aiming to maintain natural aesthetics.

The use of soft adaptation measures like NbS offers a couple of distinct advantages in the Maldives compared to gray solutions. Firstly, these approaches preserve both coastal protection and other valuable ecosystem services that are integral to reef-island systems, such as food security, climate change mitigation, and biodiversity conservation.[341] Secondly, soft adaptation avoids the visual disruption associated with hard adaptation infrastructure like concrete seawalls, which is particularly relevant for resort islands aiming to maintain natural aesthetics. On the other hand, when compared to hard-engineered solutions, two potential downsides of soft adaptation are that maintenance often requires a long-term financial commitment and that the effectiveness is more dependent on local factors. These local factors include the intactness of the dynamic functioning of the reef-island system and space limitations. Consequently, it is important that soft adaptation measures are considered alongside hard adaptation measures with an eye on the context in which they might be applied. The GoM's ambition to develop trade-off criteria to help decide between hard and soft adaptation is a critical first step towards integrating soft adaptation into coastal adaptation planning. In the long run, there needs to be a paradigm shift away from predominantly hard-engineered solutions to a more inclusive approach that acknowledges the value of ecosystems like coral reefs, mangroves, and seagrasses as integral components of coastal defense.

While the cost-effectiveness of NbS in SIDS such as the Maldives has yet to be conclusively determined, studies from other parts of the world have demonstrated promising results.

While the cost-effectiveness of NbS in SIDS such as the Maldives has yet to be conclusively determined, studies from other parts of the world have demonstrated promising results.[342] These studies indicate that the benefits of NbS often exceed their costs, making them a more cost-effective alternative to traditional engineering solutions. For instance, an analysis of 52 coastal protection projects in the United States showed that NbS were up to five times more cost-effective than hard engineering solutions.343 In another comparative study, it was estimated that coral reef restoration projects in tropical regions (at a cost of US$ 1,290 per meter) were 15 times more cost-effective than artificial breakwaters (which cost approximately US$ 19,791 per meter) when it comes to providing similar levels of wave attenuation benefits. These findings suggest that NbS could provide a financially viable and environmentally sustainable alternative for coastal protection in the Maldives and other SIDS.[344]

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341 Government of Maldives. (2019). Strategic Action Plan 2019-2023. https://storage. googleapis.com/presidency.gov.mv/Documents/SAP2019-2023.pdf

342 Seddon, N. , Chausson, A. , Santos, R. , Girardin, C. a. J. , Turkelboom, F. , & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. The Royal Society Publishing, 375(1794), 20190120. https://doi.org/10. 1098/rstb. 2019. 0120

343 Narayan, S. , Beck, M. , Reguero, B. G. , Losada, I. J. , Van Wesenbeeck, B. K. , Pontee, N. , Sanchirico, J. N. , Ingram, J. A. , Lange, G. , & Burks-Copes, K. A. (2016). The Effectiveness, Costs and Coastal Protection Benefits of Natural and Nature-Based Defences. PLOS ONE, 11(5), e0154735. https://doi.org/10. 1371/journal. pone. 0154735

344 Ferrario, F. , Beck, M. , Storlazzi, C. D. , Micheli, F. , Shepard, C. C. , & Airoldi, L. (2014). The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. Nature Communications, 5(1). https://doi.org/10. 1038/ncomms4794

Box 9. IUCN framework for the verification, design and scaling up of NbS.

The Global Standard for Nature-based Solutions by IUCN (2020) outlines eight criteria to enhance the trustworthiness, and sustainability of NbS interventions. The Standard is designed to facilitate the verification, design, and scaling up of NbS, reinforcing best practices and addressing existing shortfalls. Its primary goal is to guarantee that interventions adhere to internationally accepted NbS principles, promoting consistent and quality-assured application across diverse contexts. Below, we provide an overview of the eight criteria.

1. *NbS effectively address societal challenges* — NbS must directly address prioritized societal challenges, identified through an inclusive process involving all key stakeholders, particularly those directly affected. The challenges addressed should be clearly understood, well-documented, and result in tangible benefits to human well-being, with outcomes periodically assessed and benchmarked using targets.

2. *Design of NbS is informed by scale* — This criterion mandates a nuanced NbS design, accounting for site specific aspects of complexity and dynamism of ecosystems. It emphasizes using a three-scale framework to understand various interactions and encourages maintaining ecosystems' productive capacity. The design should recognize and respond to interactions between the economy, society, and ecosystems, integrate with other interventions to find synergies, and incorporate risk management beyond the immediate intervention site.

3. *NbS result in a net gain to biodiversity and ecosystem integrity* — The health of an ecosystem is vital as NbS derive goods and services from it. The design of NbS should not only avoid harming the ecosystem but actively enhance its functionality and connectivity. Actions should be based on thorough assessments, have clear biodiversity targets, monitor for unintended effects, and aim to improve ecosystem connectivity.

4. *NbS are economically viable* — A thorough evaluation of the return on investment, efficiency, effectiveness, and equitable distribution of benefits and costs, both at the NBS design stage and throughout implementation is critical. This criterion therefore highlights the need to balance short-term costs with long-term gains, and warns against the risks of NbS becoming short-lived projects if economic feasibility is not adequately addressed. Indicators for this criterion focus on the identification and documentation of benefits and costs, the provision of a cost-effectiveness study, justification of the NbS design against alternatives, and consideration of a diverse portfolio of resourcing options. To enhance the likelihood of long-term success, the criterion encourages innovative financing and the use of evidence-based tools for valuing nature.

5. *NbS are based on inclusive, transparent and empowering governance processes* — To enhance social acceptance and sustainability, criteria 5 emphasizes the involvement of stakeholders, especially rights holders. As part of this process, legal and regulatory provisions must be followed, local communities must be actively engaged and empowered, and mechanisms for feedback and grievance resolution must be established. For transboundary NbS, the criterion also stresses mutual respect and equality in participation, involvement of all affected stakeholders, transparency and responsive decision-making, and joint decision-making across jurisdictions.

6. *NbS equitably balance trade-offs between achievement of their primary goals and the continued provision of multiple benefits* — While trade-offs in NbS interventions are inevitable, they can be managed effectively with fair, transparent, and inclusive processes.

7. *NbS are managed adaptively, based on evidence* — The management of NbS must be adaptive, based on continuous monitoring and evaluation, as this addresses the inherent uncertainty of managing dynamic ecosystems. In order to remain relevant and effective throughout the lifecycle of an NbS intervention, an iterative learning framework and comprehensive monitoring and evaluation plans are essential.

8. *NbS are sustainable and mainstreamed within an appropriate jurisdictional context* — In order for NBS to be sustainable, they should align with various policy frameworks and be mainstreamed across different sectors and levels. This criterion stresses the importance of strategic communications and outreach to individuals, institutions, and global networks. Furthermore, the criterion emphasizes the importance of sharing knowledge and lessons learned from NbS implementation for facilitating transformative change and contributing to national and global targets.

345 IUCN (2020). Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. First edition. Gland, Switzerland: IUCN.

The site-specific nature of NBS as well as a lack of systematic testing, monitoring and reporting makes their long term reliability and efficiency for general application in the Maldives unknown.

Despite the clear advantages to NbS approaches to coastal resilience and adaptation, there are some potential tradeoffs. For one, the site-specific nature of NBS as well as a lack of systematic testing, monitoring and reporting makes their long term reliability and efficiency unknown. This uncertainty negatively affects the acceptance of nature-based flood protection measures among the general public. While adaptation funds are starting to promote the implementation of NbS (such as the case of Cuba's MI COSTA project),[346] they generally have to compete with hard engineering coastal protection measures for funding. There is also a perception among planners and the general public that soft engineering solutions are less effective than hard engineering solutions.[347] The experience of the 2004 tsunami changed some of these perceptions positively, which is in line with evidence of the protective role that reefs and mangroves had during this event.[348,349] Other social barriers in the Maldives may also hinder NBS implementation, including marginalization and power differences.[350] The implementation of NBS also requires technical capacity and novel institutional arrangements, such as the inclusion of coral reef ecosystems in the country's NDC adaptation goals, which is currently not the case.

Photo Description: Tsunami damaged island of Kandholhudhoo, Maldives © Wikipedia https://en.wikipedia.org/wiki/File:Tsunami_damaged_island_of_kandholhudhoo_maldives.jpg

346 Fund, G. C. (n.d.). FP157: Coastal Resilience to Climate Change in Cuba through Ecosystem. Green Climate Fund. https://www.greenclimate. fund/project/fp157

347 Sovacool, B. K. (2012). Expert views of climate change adaptation in the Maldives. Climatic Change, 114, 295–300

348 RAMSAR. (2005). Background information on the Indian Ocean tsunami and the mitigation of natural disasters. https://ramsar.org/sites/default/files/documents/pdf/sc/31/key_sc31_doc30. pdf

349 Environment Justice Foundation (n.d.). Mangroves: Nature Defence Against Tsunamis. A report on the impact of mangrove loss and shrimp farm development on coastal defences. https://ejfoundation.org/resources/downloads/tsunami_report. pdf. PdfCompressor-1022348. pdf

350 Clissold, R. , McNamara, K. E. , & Westoby, R. (2020). Barriers to adaptation: Insights from Laamu Atoll, Maldives. Asia Pacific Viewpoint, 61(2), 381–390. https://doi.org/10. 1111/apv. 12258

Box 10. Examples of Nature-Based Solutions

Limited understanding of the costs and benefits of NbS for coastal protection at the project level is known to restrict investment scaling. The World Bank's Global Facility for Disaster Reduction and Recovery (GFDRR) report[316] offers actionable methods and a decision framework to guide the design of NbS, addressing the challenges faced by developers in evaluating NbS benefits. The framework considers the entire NBS project's life cycle including capital expenditures (CAPEX) such as design, planning, and construction costs, in addition to operating expenses (OPEX) such as monitoring, maintenance, and operation. Aside from opportunity and transaction costs, NBS costs also include negative externalities and disservices. Drawing from the framework, the report evaluates a number of case studies.

Blue Barrier Hybrid NbS in the Seychelles

In Seychelles, the World Bank is facilitating the development of a "Blue Barrier" approach, a pioneering initiative that merges coral reef restoration with risk mitigation strategies. This ongoing pilot project integrates coral reef restoration with risk reduction strategies, requiring the installation of 1,300 to 1,700 artificial reef units across an area of roughly 6,354 m². The cost per unit ranges from $1,500 to $2,000. The project also incurs ongoing maintenance costs estimated at $100,000 over 18 months, covering activities such as coral nursery establishment, transplantation, capacity building, and monitoring across a 500–600 m² area. The initiative is designed to mitigate a variety of coastal risks, aiming to enhance the resilience and stability of the region. In the event of a 50-year flood combined with sea-level rise, it is expected to protect 174 properties, reducing the vulnerability of essential assets such as buildings and roads, and thus diminishing coastal flood exposure. Additionally, the offshore Blue Barrier is projected to contribute to wave energy reduction, with an anticipated additional decrease of 28%, further safeguarding the coastal area. The initiative also addresses sediment mobility, aiming to reduce longshore sediment transport rates by up to 74% during a 50-year Average Recurrence Interval (ARI) event. This reduction is vital for promoting sand accumulation, maintaining the beach's structure, and preventing erosion, ultimately contributing to the long-term sustainability and integrity of the coastal settlements in Seychelles.

Mangrove restoration in Indonesia

Mangrove restoration over a 30-year project lifespan, applying a 5.5 percent discount rate to present value future costs and benefits for comprehensive analysis. To test the resilience of the results, sensitivity analysis with 0 percent and 10 percent discount rates were also conducted. On average, the ecosystem services provided by mangroves generate benefits of approximately $15,000 per hectare per year, with some areas yielding benefits up to nearly $50,000 per hectare per year. These benefits, however, vary significantly across different regions and types of services, with the protection of coastlines and fisheries emerging as the most financially beneficial services. The estimated average cost for mangrove restoration in Indonesia stands at $3,900 per hectare. However, the opportunity costs associated with conservation and restoration are both high and variable, highlighting the necessity for tailored investment strategies. The net present opportunity costs average $3,400 per hectare, with higher costs in regions experiencing faster depletion rates. While restoration net benefits generally surpass conservation net benefits, regional disparities must be taken into account when making investment decisions.

Artificial coral reefs in Mexico

In 2008, the Now Jade Riviera Resort (Cancun, Mexico) started considering Nature-Based Solutions to deal with local coastal erosion problems. Coastal erosion became problematic in 2007 when the coast was struck by hurricane-induced waves causing significant sand transport. An artificial breakwater was implemented to reduce longitudinal currents, but this measure induced chronic beach erosion. Hence, additional measures needed to be taken to make the beach more resilient against coastal erosion. Different options for coastal protection were considered, including gray and nature-based solutions. After considering the options, an artificial coral reef was selected as the solution of choice in 2010. This solution was expected to be effective at wave energy reduction, to be aesthetically and ecologically sound, and to benefit from coral species colonization due to the proximity of the Mesoamerican Reef. After various site-specific and laboratory tests, two modular artificial reefs

351 Boris van Zanten, Gonzalo Gutierrez Goizueta, Luke Brander, Borja Gonzalez Reguero, Robert Griffin, Kavita Kapur Macleod, Alida Alves, Amelia Midgley, Luis Diego Herrera, and Brenden Jongman. 2023. Assessing the Benefits and Costs of Nature-Based Solutions for Climate Resilience: A Guideline for Project Developers. World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO

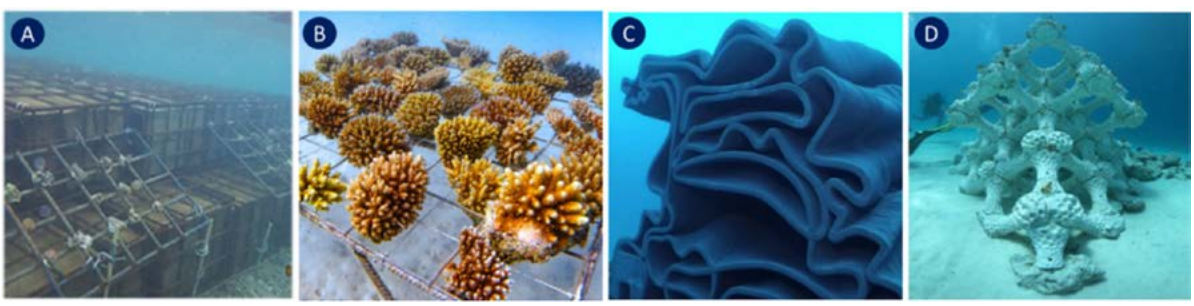
were assembled and placed 120 meters off the coast. The effectiveness of the artificial reefs was assessed after five years post-construction. The assessment showed positive impacts on beach recovery and also contributed to local fish and coral colonies.

Mangrove restoration in Jamaica

Like many other Caribbean and island nations, Jamaica is at risk from coastal flooding and associated hazards. Vulnerable coastal communities in Jamaica can receive significant flood protection benefits from restoring natural habitats such as mangroves and coral reefs. Restoring these ecosystems also brings about other benefits, such as fish habitat provision. Along these lines, several mangrove restoration projects have been carried out in Jamaica in the past decade. For example, the University of the West Indies worked on mangrove restoration in several small-scale pilot sites between 2015 and 2020. Although the pilot sites do not have long-term monitoring programs that measure contributions to coastal protection, the World Bank's Forces of Nature study[317] estimated the average economic benefits of these and other mangrove restoration projects in Jamaica. This study found that restoring one hectare of mangroves in Jamaica provides (on average) more than US $2,500 per year of flood reduction benefits from tropical cyclones. When considered over 30 years, the average coastal protection benefits would exceed $43,000 per hectare of restored mangroves. These benefits exceed the average restoration costs of $30,000 per hectare, although restoration costs can vary substantially between sites. Estimates of the economic benefits also varied substantially between locations with varying population densities and exposures to storm surges. Site-level estimates of the wave reduction potential ranged between 13 and 68 percent. This study also estimated that more than 700 hectares of mangroves have been lost in recent decades in Jamaica. However, the restoration potential is vast in Jamaica: more than two-thirds of these lost mangroves can potentially be restored.

Figure 53. There are various emerging coral restoration techniques

A.*Pilot unit made with gabion baskets and rocks in Grenade;*[353] B. *Metal structure using mineral accretion technology in Maldives* [354] *C. 3D-printed concrete artificial reef in the Calanques National Park* [355] *D. MARS project: 3D-printed artificial module in Maldives.*[356]



Source: World Bank, adapted from Reguero et al. 2018; Coralive, Seaboost and XtreeE, and Alex Goad-MARS).

There are many examples of nature-based coastal protection efforts by resorts in the Maldives. Many resorts conduct small-scale coral restoration

352 World Bank 2019, https://onlinelibrary.wiley.com/doi/full/10.1111/disa.12539#disa12539-bib-0073

353 Reguero, B. G., Beck, M. W., Agostini, V. N., Kramer, P., & Hancock, B. (2018). Coral reefs for coastal protection: A new methodological approach and engineering case study in Grenada. Journal of environmental management, 210, 146-161. Retrieved from https://www.sciencedirect.com/science/article/pii/S0301479718300240

354 Coralive.org. (n.d.). Retrieved from https://www.coralive.org/en/

355 XTreeE. (n.d.). XReef. Retrieved from https://xtreee.com/en/project/xreef/

356 Goad, A. (n.d.). MARS. Retrieved from https://www.alex-goad.com/mars

In terms of NBS for food security, aquaculture activities can be better integrated into mangrove forests that can offer shelter to the farmed species and simultaneously protect coastal assets.

activities in response to demand from tourists. These activities consist of tying coral fragments onto artificial coral frames (see Figure 53). The initial cost per frame varies between $150 for small frames (covering 0.6 m2 of the sea floor) and $500 for large frames (covering 3.1 m2 of the sea floor).[357] Continuous coral cover can be achieved after 3 years (seen from above). Many resorts collaborate with a marine consultancy firm (Reefscapers), which has so far been involved in placing 8,500 coral frames in the Maldives.[358] The total impact of these efforts is small, however, as they in total add up to 0.03 km2 of additional coral cover (assuming successful coral growth on 8,500 large frames), which is negligible compared to the total surface of corals in Maldives (8,900 km2). The Four Seasons Resort Maldives at Kuda Huraa engaged in this kind of NbS approach, begining restoration of local reefs in collaboration with Reefscapers in 2001. Another example is the Amaya Kuda Rah Maldives resort, who placed the first frames on the north-east side of the reef in 2017. After two to three weeks, coral fragments had attached themselves onto the frame. Two months later, there was visible new coral growth. One of the most recently started projects is that of the St. Regis Maldives Vommuli Resort, who planted 33 coral frames around the island in 2023.

While coral reef restoration can directly foster coastal protection, the effective development of Marine Protected Areas can further aid this effort.

In terms of NBS for food security, aquaculture activities can be better integrated into mangrove forests that can offer shelter to the farmed species and simultaneously protect coastal assets. For example, associated mangrove aquaculture or mangrove-based aquaculture seeks to restore mangrove green belts along shorelines and waterways, which dampens waves and builds up sediments that in turn protect aquaculture ponds and coastal communities from flooding and inundation. Furthermore, the edible shoots of some mangrove species such as Bruguiera gymnorhiza are sometimes used as famine food in atolls in the Maldives and Papua New Guinea. There is also growing awareness of aquaculture infrastructure, such as long-line culture of shellfish and seaweeds, as a nature-based alternative to coastal armoring. Aquaculture infrastructure could be developed in atoll lagoons. The sea pens for other species cultured in the Pacific such as sea cucumbers and milkfish, could also be designed and arranged in lagoons to provide similar coastal protection benefits.

Maintaining or restoring an ecosystem for NbS, especially the reef system, implies acting on various components of this system, including the nearshore and intertidal zones. Natural ecosystems change and develop over time, influencing their ability to provide services such as coastal protection. For instance, young mangrove forests don't offer the same storm surge protection or erosion control as mature ones. Degraded ecosystems may require significant restoration efforts before they can effectively contribute to coastal protection. This implies that a singular approach might not be sufficient, and a combined approach of multiple NbS is imperative. While coral reef restoration

357 Reefscapers. (n.d.) Reefscapers – Marine Consulting in the Maldives. https://reefscapers.com/

358 ibid

Beach vegetation plays a critical role in preserving coastal ecosystems, and employing it as an NBS offers multiple benefits. Among the initiatives, large seagrass restoration projects...are vital for stabilizing coastlines.

can directly foster coastal protection, the effective development of Marine Protected Areas can further aid this effort. By leveraging the natural coastal protection services provided by the reef-island system and integrating strategies like coral farming, assisted evolution, and mangrove replanting, atoll islands can enhance their coastal protection. While coral reef restoration can directly foster coastal protection, the effective development of Marine Protected Areas can further aid this effort.

Beach vegetation plays a critical role in preserving coastal ecosystems, and employing it as an NBS offers multiple benefits. Among the initiatives, large seagrass restoration projects, particularly targeting species like Zostera marina, are vital for stabilizing coastlines. Seagrass species can be crucial in terms of retaining sediment by reducing near-bed flow velocity and wave energy.[359,360] Protecting, planting, and restoring littoral vegetation (non-mangrove trees like palms and dune vegetation) is also an effective way to mitigate the impacts of storms or erosion. While the use of vegetation on non-atoll coasts against erosion abounds, less research exists on atolls. Other littoral[361] vegetation can also enhance sediment accretion (by trapping sediment either from aeolian deposition or wave deposition), although to a lesser extent than mangroves. Other littoral vegetation can also help mitigate the impact of storms by attenuating wave energy and increasing soil cohesion and so reducing erosion. Likewise, human-made wetlands and restored salt marshes can expand (add water volume) in response to sea-level rise and storm surge conditions. The Wallasea Island Wild Coast project in the UK[362] is an example of a coastal wetland that was restored to increase the water storage capacity and lower inland storm surges.

NbS should not be thought of as being opposed to non-NbS options, but rather as being part of a more comprehensive and integrated approach to coastal protection.

NbS should not be thought of as being opposed to non-NbS options, but rather as being part of a more comprehensive and integrated approach to coastal protection. For example, the erection of an offshore breakwater in the nearshore zone, which is a hard structure, may guarantee the success of NbS aimed at restoring the various components of the reef-island system. In settings where space for traditional NbS is insufficient, adopting hybrid approaches that combine gray (engineered) and green (nature-based) infrastructure can offer a balanced solution. Living shorelines, for example, integrate natural elements like vegetation with harder, engineered structures to protect coastlines while providing habitat and maintaining natural coastal processes. This approach allows for the incorporation of NBS even in more developed, space-constrained areas.

359 Brodie et al. (2020). Seagrass habitat in Tarawa Lagoon, Kiribati: Service benefits and links to national priority issues. Mar. Poll. Bull. 155, 111099

360 Risandi, J. , Rifai, H. , Lukman, K. M. , Sondak, C. F. A. , Hernawan, U. E. , Quevedo, J. M. D. , Hidayat, R. , Ambo-Rappe, R. , Lanuru, M. , McKenzie, L. , Kohsaka, R. , & Nadaoka, K. (2023). Hydrodynamics across seagrass meadows and its impacts on Indonesian coastal ecosystems: A review. Frontiers in Earth Science, 11. https://doi.org/10. 3389/feart. 2023. 1034827

361 relating to or situated on the shore of a body of water.

362 Davis et al. (2015). Coastal Protection and SUDS. https://ec.europa.eu/environment/integration/green_semester/pdf/Recreate_PB_2015_NBS_final_druck10-02-2016.pdf

In locations where environmental stressors have eroded natural barriers like reefs and mangroves more rapidly than they can regenerate, the combination of engineered structures with NbS provides an immediate line of defense.

These hybrid NbS/hard infrastructure approaches that add engineering measures into reef restoration may enhance co-benefits, though there are very few examples of this on coral reefs and atolls. In locations where environmental stressors have eroded natural barriers like reefs and mangroves more rapidly than they can regenerate, the combination of engineered structures with NbS provides an immediate line of defense. Such an approach allows for initial coastal protection while giving nature time to establish itself and eventually deliver a broader array of benefits, including long-term coastal defense. Once restored, natural systems can further enhance and prolong these protective capabilities. For instance, there have been efforts at reef enhancements that include coral transplantation (Abelson 2006). This involves deploying artificial structures to reinforce and protect existing coral reefs, followed by the transplantation of resilient coral species onto these structures. These artificial constructs act as a barrier, absorbing and diminishing wave energy, while the transplanted corals grow and strengthen the natural barrier over time. There is also scope for such structures to contribute to existing as well as new aquaculture projects; for example, in the form of cages containing giant clams, or structures that help anchor infrastructure for fish farms. Yet there is insufficient knowledge to inform practice (Barnet et al. 2021). Other examples include artificial oyster reefs created in New York, USA and the Oosterschelde, Netherlands, which both contributed to wave attenuation and erosion protection (Davis et al. 2015).

Box 11. Nature-based solutions in NDC Adaptation goals: The case of the Seychelles

The Seychelles is implementing several Nature Based Solutions that help protect against coastal flooding and erosion. In its 2021 NDC resubmission, the Seychelles acknowledged the importance of protecting the blue economy and blue carbon ecosystems by:

- Regulating coastal planning and infrastructure at the national and local level and to prioritize the consideration of "blue" Nature-based Solutions (NbS) for climate resilience.
- Protecting blue carbon ecosystems, i.e., at least 50% of its seagrass and mangrove ecosystems by 2025, and 100% of seagrass and mangrove ecosystems by 2030;
- Establishing a long-term monitoring program for seagrass and mangrove ecosystems by 2025 and including the GHG sink of Seychelles' blue carbon ecosystems within the National Greenhouse Gas Inventory by 2025;
- Implementing a Marine Spatial Plan and the effective management of the 30% marine protected areas within the Seychelles' Exclusive Economic Zone;

In addition, Seychelles commits to continue integrating climate change considerations into plans and strategies across all key sectors by 2030, and to promote coastal and marine ecosystem connectivity by:

- Prioritizing nature-based solutions to protect against climate-related impacts such as storm surges, flooding and erosion, using its Coastal Management Plan as a guideline for implementation;
- Adopting an integrated Ridge-to-Reef approach to coastal management that brings together the Seychelles Marine Spatial Plan, the Coastal Management Plan, the Blue Economy Roadmap, the National Biodiversity Strategy and Action Plan and other plans to guide the development in sectors such as fisheries and aquaculture, tourism, agriculture, waste management, water resources, biodiversity conservation and urban development

The CVI provides a framework for evaluating and comparing the susceptibility of different islands to potential risks such as sea-level rise, storm surges, erosion, and other related factors.

An integrated National Land and Ocean Monitoring System to track coastal-marine ecosystems and their changes over time is urgently needed to foster NbS in the Maldives.

2.3.5 A Coastal Vulnerability Index for the Maldives

Box 12. Insight into CVI Assessment Components

Vulnerability assessment serves as a foundational tool to understand the "degree to which human and natural systems are susceptible to, and unable to cope with, adverse impacts" of environmental changes, notably climate change.[364] The assessment revolves around three integral components:

- **Exposure**: The nature and degree to which a system is exposed to significant climatic variations.
- **Sensitivity:** How the system is affected, negatively or positively, by climate-related stimuli.
- **Adaptive Capacity:** The ability to adjust to potential harm, take advantage of opportunities, or respond to the consequences.

Choosing the appropriate "indicators" for the CVI hinges on both the intent of the assessment and the timeframe under review. In the Maldives, not all islands or regions are vulnerable in the same way. Factors like location, socio-economic conditions, demographic trends, local livelihood patterns, and other contextual circumstances influence these variations. For instance, certain islands may demonstrate higher adaptive capacity due to robust local governance and responsive institutional mechanisms, despite high exposure to significant climatic hazards. What's deemed 'low-risk' today might transform into a vulnerable hotspot in the future due to evolving socio-ecological conditions. Especially in the Maldives, even minor sea-level changes or human-led activities like dredging can significantly modify an island's vulnerability profile.

It is important to note that CVI serves as a baseline assessment of vulnerability, highlighting areas where further investigation and targeted interventions may be required. Building on this initial analysis, the CCDR will delve deeper into these areas, encompassing climate impact assessments, socio-economic assessments, scenario planning, and participatory rural appraisals.

In the Maldives, not all islands or regions are vulnerable in the same way. Factors like location, socio-economic conditions, demographic trends, local livelihood patterns, and other contextual circumstances influence these variations.

The Coastal Vulnerability Index (CVI) is a quantitative measure used to assess and rank the relative vulnerability of coastal areas to the impacts of coastal hazards and climate change. The CVI provides a framework for evaluating and comparing the susceptibility of different islands to potential risks such as sea-level rise, storm surges, erosion, and other related factors. The CVI can be used by policymakers, planners, and decision-makers in the Maldives to help in prioritizing vulnerable coastal regions. This allows for informed decision-making regarding land use planning, infrastructure development, and the implementation of coastal protection measures. A valuable guide in the management of coastal areas, the CVI can aid the Maldives in adapting to climate change and reducing the potential impacts of coastal hazards on its islands and communities.[363] Box

363 Gornitz, V. (1990). Vulnerability of the east coast, USA to future sea level rise. Journal Citation Reports, 9. https://www.osti.gov/servlets/purl/5875484

The resulting extreme water heights that currently happen once every 100 years are expected to happen once a year by 2050.

12 outlines the components central to CVI development.[364]

Mean SLR is included in many CVIs because it is a main driver of coastal hazards. However, mean SLR is not included in the CVI for the Maldives because regional variations are observed only at spatial scales that extend beyond the geographical extent of the Maldives.[365,366] On the other hand, mean SLR will increase the frequency of extreme water heights that are presently observed in the Maldives. Extreme water heights vary along the north-south axis in the Maldives due to local variations in storm surges, astronomical tides, and, in rare cases, due to tropical cyclones.[367] The resulting extreme water heights that currently happen once every 100 years are expected to happen once a year by 2050. In this CVI, historical extreme water heights are included as an indicator of the intensity of coastal floods that will be frequently observed in the future. As far as geomorphology is concerned, landforms are often included in CVIs that cover large geographical areas with landforms that are very resistant against erosion (e.g., rocky cliffs) and other landforms that are less resistant (e.g., coral reefs and sandy beaches). Within the Maldives, landform is not a differentiating factor for coastal vulnerability because all islands in the Maldives are composed of sediment produced on nearby coral reefs, with the exception of reclaimed islands.[368] On the other hand, the shape and size of the reef flats surrounding the islands determine how much wave energy reaches the shorelines. Specifically, the amount of wave energy reaching the shores decreases with reef flat width up to 1,000 meters, and wave heights are proportional to reef depth.[369]

In the Maldives CVI, average water depth is included to account for the width and shallowness of reef flats within 1,000 meters from the shoreline. The compactness of islands is also included because each island's total exposure to coastal threats increases with coastline length. The CVI also considers whether islands are located on the outer edge of an atoll as these islands are directly exposed to ocean swell waves, but does not include terrain elevation because (i) available land survey data do not cover all inhabited islands, and (ii) elevation differences between islands are

364 Parry, M., Canziani, O., van Ypersele de Strihou, J. P., & Palutikof, J. (2007). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

365 Sreeraj, P. , Swapna, P. , Krishnan, R. , Nidheesh, A. , & Sandeep, N. (2022). Extreme sea level rise along the Indian Ocean coastline: observations and 21st century projections. Environmental Research Letters, 17(11), 114016. https://doi.org/10. 1088/1748-9326/ac97f5

366 Palanisamy, H. , Cazenave, A. , Meyssignac, B. , Soudarin, L. , Wöppelmann, G. , & Becker, M. (2014). Regional sea level variability, total relative sea level rise and its impacts on islands and coastal zones of Indian Ocean over the last sixty years. Global and Planetary Change, 116, 54–67. https://doi.org/10. 1016/j. gloplacha. 2014. 02. 001

367 Muis, S. , Verlaan, M. , Bierkens, M. F. P. , Aerts, J. C. J. H. , & Ward, P. B. (2016). A global reanalysis of storm surges and extreme sea levels. Nature Communications, 7(1). https://doi.org/10. 1038/ncomms11969

368 Perry, C. T. , Kench, P. S. , O'Leary, M. J. , Morgan, K. , & Januchowski-Hartley, F. A. (2015). Linking reef ecology to island building: Parrotfish identified as major producers of island-building sediment in the Maldives. Geology, 43(6), 503–506. https://doi.org/10. 1130/g36623. 1

369 Ferrario, F. , Beck, M. , Storlazzi, C. D. , Micheli, F. , Shepard, C. C. , & Airoldi, L. (2014). The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. Nature Communications, 5(1). https://doi.org/10. 1038/ncomms4794

Since 2002, more than 10 square kilometers of lagoon and reef area have been altered for land reclamation, representing roughly 3.4% of the entire country's land area.

masked by larger vertical errors in digital elevation models.[370] Elevation data with sufficient vertical accuracy should be included in a future CVI of the Maldives once this data becomes available. The indicators and the corresponding measurement units are presented in Table 7 below.

Table 7. Variables included in the Coastal Vulnerability Index

Indicator	Measurement unit	Data source
Reef flats	Mean water depth (meters) within 1 kilometer from shoreline	Rasheed et al. 2021. An Improved Gridded Bathymetric Data Set and Tidal Model for the Maldives Archipelago. Earth and Space Science, 8, 5
Extreme water height during flood that occurs once every 100 years	Meters above mean sea level	Muis S, et al.2016. A global reanalysis of storm surges and extreme sea levels. Nat Commun. 27, 7:11969
Presence of coastal buildings and infrastructure near shoreline	m2 built-up area within 50m from shoreline	Zanaga, D., et al 2022. ESA WorldCover 10m 2021 v200. (esa-worldcover.org)
Island compactness	The ratio of the area of the circle with the same length as the island to the island are	Own calculations based on shorelines derived from ESA land cover map
Island location	Ocean side (1) or lagoon side (0)	Maldives Land and Survery Authority
Population size	Total resident population	Statistical Yearbook of Maldives 2021 (statisticsmaldives.gov.mv)

The Maldives' CVI includes a set of physical and socio-economic factors. Most previous CVI applications included physical variables, such as sea level rise, landforms, wave height, tidal range, elevation, and shoreline change.[371,372] Some CVIs also included socio-economic variables to better identify regions with the greatest potential for monetary and non-monetary losses.[373] Commonly used socio-economic variables include population size and land use types. Importantly, if a variable that drives coastal erosion and flooding does not vary between locations within the area of interest, then all locations are similarly affected by this variable. Hence, only variables that vary within the area of interest help to highlight the most vulnerable locations. Two socio-economic variables are included in the Maldives' CVI: population, and the total surface area of urban infrastructure and buildings within 50 meters from the coastline to account for the value of coastal assets at risk. According to the CVI islands in the southern atoll are more vulnerable to coastal hazards (see Figure 54).

370 One of the most accurate digital elevation models published reports a mean absolute vertical error of at least 1.12 meters (Hawker et al 2022 Environ. Res. Lett. 17 024016). This error masks much of the variation in ground elevation. In particular, a synthesis of land surveys published by the Maldives Land and Survey Authority suggests that almost half of the Maldives' land area varies between 0 and 1.12 meters.

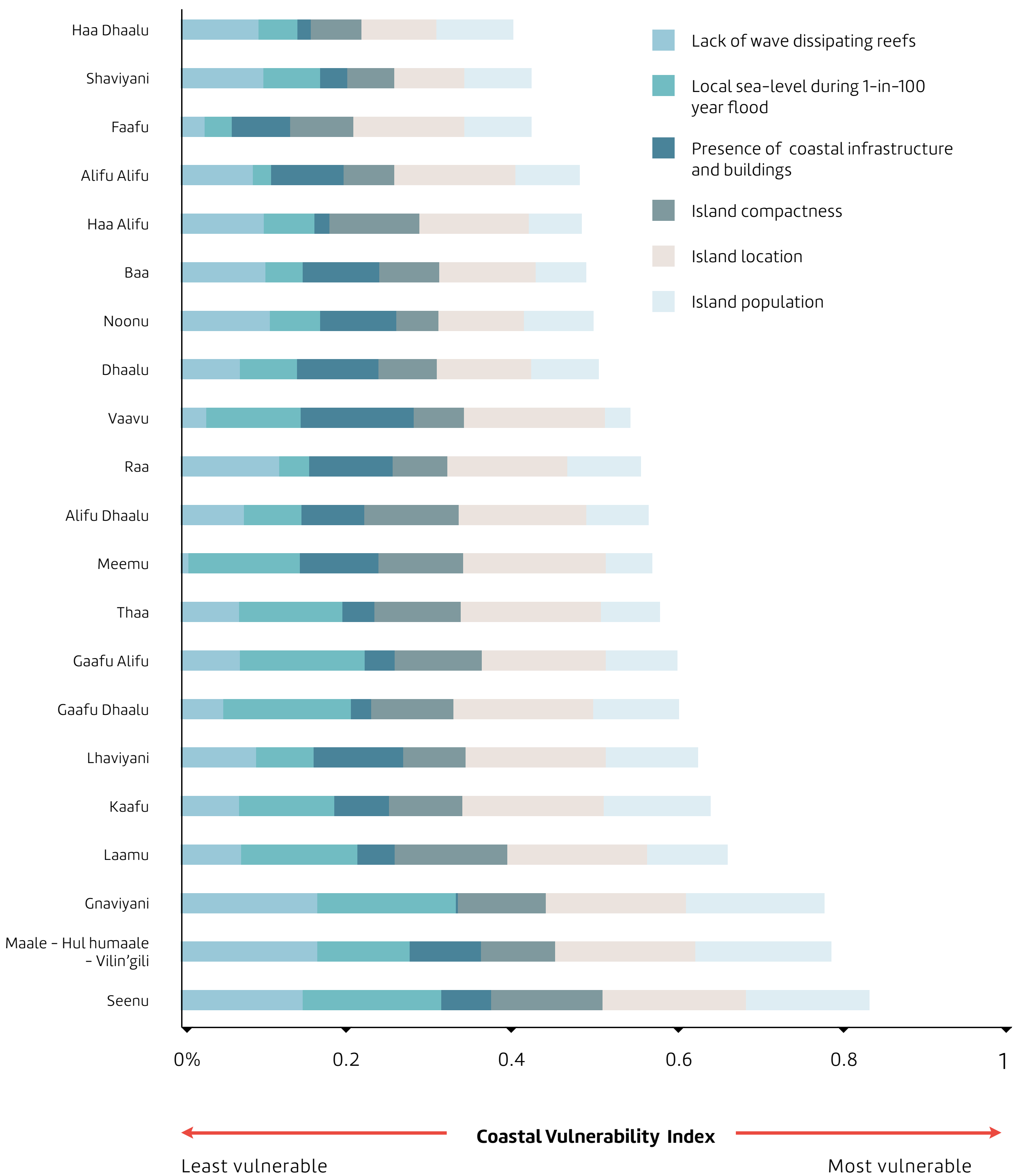
371 ibid.

372 USGS. (n.d.). National Assessment of Coastal Vulnerability to Sea-Level Rise: Preliminary Results for the U. S. Atlantic Coast, USGS Open-File Report 99-593, Coastal Vulnerability Index. https://pubs. usgs.gov/of/1999/of99-593/pages/cvi. html

373 McLaughlin, S. , McKenna, J. A. , & Cooper, J. (2002). Socio-economic data in coastal vulnerability indices: constraints and opportunities. Journal of Coastal Research, 36, 487–497. https://doi.org/10. 2112/1551-5036-36. sp1. 487

Figure 54. Islands in the Southern atolls are generally more vulnerable to coastal threats.

Coastal Vulnerability Index, averaged by atoll.



Source: World Bank.

2.3.6 Recommendations

Short-term recommendations

Integrate the planning of marine and coastal land use across key sectors. This is necessary because the environmental and societal impacts of development plans, policies, and projects in one sector can have substantial implications for other sectors. Examples of these interlinkages include the apparent increased need for beach protection investments in islands where dredging and port development projects are implemented, and the negative impact of sedimentation from land reclamation projects on corals in nearby Marine Protected Areas. These and other interlinkages between different sectors require coordination of development trajectories within an overarching framework. The integrated planning framework should be mutually linked with a robust Strategic Environmental Assessment (SEA) process (see Section 4.5), as well as sectoral plans, including the Fifth Tourism Master Plan (see Section 3.2.1) and coastal infrastructure development plans.

Photo Description: The Board Walk at Bandaara Kilhi Wetlands, at Fuvahmulah Nature Park, Fuvamulah, Maldives © World Bank

Mitigate the spillover effects of coastal infrastructure projects. Coastal infrastructure projects can inadvertently cause substantial erosion in nearby areas, leading to additional costs that exceed the project's initial scope and timeline. The re-design or re-location of existing small ports or harbors may be needed to alleviate coastal erosion issues. By considering these potential impacts during the planning and design stages of new infrastructure, and extending EIAs to a defined area beyond the immediate project area, more optimal decisions about key project details, such as location, size, and type of infrastructure, can be made. Ensuring that environmental impacts are avoided or minimized by means of the mitigation hierarchy will also improve coastal infrastructure design (see Section 4.5).

Increasing awareness among island councils regarding the full implications of coastal development projects. Such projects can inadvertently induce significant coastal erosion in adjacent areas, which may manifest long after the project's completion and result in unforeseen environmental and financial burdens. Additional investments in coastal protection measures may be necessary in order to deal with these issues. This means that the net benefits of coastal development projects may be overestimated if these inherent costs are not included in the budget set aside for coastal development projects. This increased awareness will equip Island Councils to better factor in environmental considerations into development plans for which they have been carrying responsibility since the passing of the 2010 Decentralization Act (see Section 4.1.3).

Explore the potential of NbS for coastal protection. Evidence from other countries shows that NbS, such as artificial reef construction and mangrove restoration, can be much more cost-effective than conventional gray solutions. However, whether this is also the case within the Maldivian context remains largely unknown because the country is yet to implement the first planned NbS (beyond beach nourishment) on inhabited islands. Before considering NbS on a large-scale, pilot-tests should be conducted of several NbS types across different representative locations. This will generate insight into the feasibility, efficacy, and costs of implementing NbS at a national scale. Ultimately, if pilot-tests lead to satisfactory results in terms of these and other performance indicators, islands where NbS are implemented could serve as a role model for other islands, potentially shifting the paradigm away from opting exclusively for traditional gray solutions.

Medium to long-term recommendations

Avoid becoming locked in into a maladaptive pathway. Gray solutions, such as seawalls and breakwaters, can paradoxically increase the vulnerability of reef islands to erosion and flooding, as well as interrupt the coastal protection service provided by coral reef ecosystems. While these solutions offer short-term benefits, they may hinder the natural ability of reef islands to adapt to sea-level rise in the long run. These negative side effects of coastal development represent a form of maladaptation. When islands become locked-in into a maladaptive pathway due to the initial choice for gray solutions, they are faced with recurring additional costs of coastal erosion mitigation. Evidence from other countries on the cost-effectiveness of NbS compared to gray solutions suggests that this maladaptive pathway is substantially more costly. Hence, maladaptation increases the risk that financing needs for climate adaptation become increasingly difficult to meet.

Prioritize coastal protection measures in a national coastal zone management strategy and integrate this in an updated National Spatial Plan. The recently finalized NSP (in 2021) in the Maldives serves as a comprehensive framework for development plans at various levels. To optimize the allocation of resources for coastal protection, it is crucial to prioritize islands based on their potential net benefits from additional protection measures. Recognizing the vital role of coastal and marine ecosystems in safeguarding reef islands, the coastal aspects within the updated NSP should be closely aligned with the ongoing development of a Marine Spatial Plan. Additionally, a robust Strategic Environmental Assessment (SEA) process should be incorporated to ensure effective integration. Given the strong interconnections between the tourism and fisheries sectors and these ecosystems, the sectoral components of zonal, regional, and island-level development plans should align with the overarching NSP, promoting consistency and coherence in sustainable development efforts.

2.4 Clean Ocean water

Lack of suitable policies, empowering legislation, and an environmentally conscious and informed public are at the heart of waste management issues.

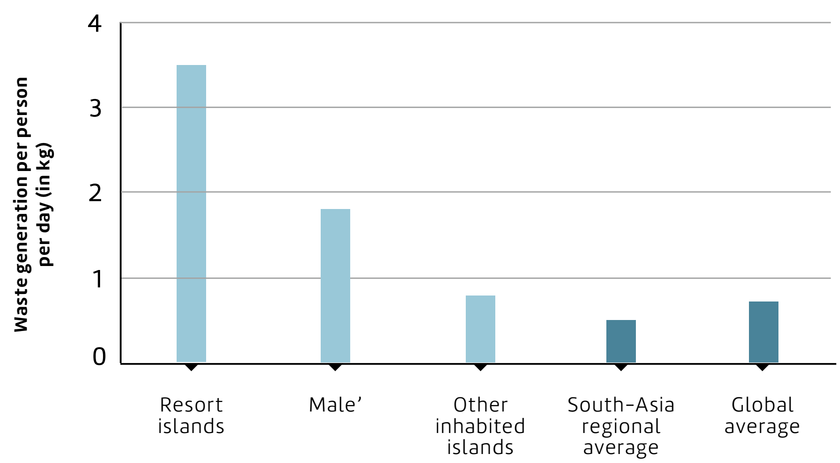
The Maldives is currently facing urgent solid and liquid waste-related issues that require immediate attention. Lack of suitable policies, empowering legislation, and an environmentally conscious and informed public are at the heart of waste management issues. The archipelago is experiencing an accumulation of waste, particularly plastic, which is polluting the naturally pristine waters around the islands. In addition, population growth has resulted in untreated wastewater becoming a major problem. This wastewater contains hazardous chemicals and pollutants that not only endanger marine life but also pose risks to public health. There is a strong need to embrace responsible waste management practices, promote sustainable approaches, foster knowledge sharing, global collaboration and allocating dedicated resources from national budgets. This Section discusses recent developments and challenges in the Maldives in terms of plastics and other waste (Section 2.4.1) and runoff and liquid waste (Section 2.4.2) and provides sets of recommendations.

2.4.1 Free from plastics and other solid waste

Waste pollution today represents an urgent threat to the Maldives' people and ecosystems. The high levels of waste generation in the Maldives (see Figure 55) are related to the critical issue of plastic waste leakage. According to Royle et al. (2022), the following factors cause an estimated 600 tons of plastic garbage to flow into Maldivian waterways every year: I) Illegal dumping in the ocean, ii) Improper transportation to other islands, such Thilafushi, and iii) Lack of protection in coastline dump sites against wind, swell waves, or storms. Toxicity, bioaccumulation, and biomagnification are other substantial concerns.[374] Further, micro-plastics and heavy metals in ocean waters have adverse health effects,[375] and when ingested by aquatic animals can lead to sublethal or lethal effects.376 Notably,[377] plastic waste ingestion by corals reduces the process of feeding on organic matter[378] and other organisms that feed on corals. This ultimately leads to the transfer of microplastics through the trophic chain.[379,380]

Figure 55. Waste generation per capita is particularly high in resort islands

Waste generation in the Maldives, South-Asia, and globally.



Source: World Bank 2017. Maldives Clean Environment Project

Some places in the Maldives have been found to have among the highest densities of microplastics in the world.[381] With concentrations in one island (Naifaru, 55 – 1127.5 microplastics/kg) being higher than in a highly populated

374 Baconguis, Beau. 2018. "Stemming the Plastic Flood. " A Break Free from Plastic Movement Report. https://www.breakfreefromplastic.org/wp-content/uploads/2018/04/Stemming-the-plastic-flood-report. pdf

375 Ebrahimi, P., Abbasi, S., Pashaei, R., Bogusz, A., & Oleszczuk, P. (2022). Investigating impact of physicochemical properties of microplastics on human health: A short bibliometric analysis and review. Chemosphere, 289, 133146.

376 Dharmadasa, W. S., Andrady, A. L., Kumara, P. T. P., Maes, T., & Gangabadage, C. S. (2021). Microplastic pollution in marine protected areas of Southern Sri Lanka. Marine Pollution Bulletin, 168, 112462.

377 Corona, E., Martin, C., Marasco, R., & Duarte, C. M. (2020). Passive and active removal of marine microplastics by a mushroom coral (Danafungia scruposa). Frontiers in Marine Science, 128.

378 Rotjan, R. D., Sharp, K. H., Gauthier, A. E., Yelton, R., Lopez, E. M. B., Carilli, J., . & Urban-Rich, J. (2019). Patterns, dynamics and consequences of microplastic ingestion by the temperate coral, Astrangia poculata. Proceedings of the Royal Society B, 286(1905), 20190726.

379 Reichert, J., Schellenberg, J., Schubert, P., & Wilke, T. (2018). Responses of reef building corals to microplastic exposure. Environmental Pollution, 237, 955-960.

380 Thushari, G. G. N., & Senevirathna, J. D. M. (2020). Plastic pollution in the marine environment. Heliyon, 6(8), e04709.

381 Patti, T. B., Fobert, E. K., Reeves, S. E., & da Silva, K. B. (2020). Spatial distribution of microplastics around an inhabited coral island in the Maldives, Indian Ocean. Science of the Total Environment, 748, 141263.

Untreated waste water can have a wide range of consequences for fisheries and fish stocks.

site in India (3–611 microplastics/kg).[382] The highest concentration of microplastics was found in shallow reef environments, and 66 percent of these micro-plastics are blue or red, making them more likely to be ingested by marine predators.[383] Not all marine waste pollution comes from local sources; long-range global ocean transport of marine plastic debris also contributes to plastics in the Maldivian waters.[384]

Clean ocean water does not only bring about ecological benefits, but also economic benefits. Tourists come to the Maldives to experience the country's beaches, and the presence of marine litter has a strong negative impact on this experience. While there is no direct evidence for the importance of clean ocean water for the Maldivian economy, there are plenty of global examples of marine pollution having negative impacts on coastal communities. For example, it was estimated that marine debris caused a 63 percent reduction in tourist arrivals in Geoje Island, South Korea.[385] Additionally, a study in California found that a 25 percent reduction in marine debris at Southern California Beaches increases recreational benefits by $30 million per tourist season.[386] The loss of coral cover due to plastic debris can also lead to a decline in tourist arrivals.387 Marine debris, particularly plastic, has been found to negatively affect fishing activities in Indonesia.[388]

Untreated wastewater in estuarine and coastal marine systems has also caused fish and shellfish abnormalities.

Untreated wastewater can have a wide range of consequences for fisheries and fish stocks. Eutrophication caused by nutrients washing into streams, for example, promotes anaerobiosis, which kills benthic and epibenthic animals in large numbers. Untreated wastewater in estuarine and coastal marine systems has also caused fish and shellfish abnormalities. Marine debris and plastic are not only a threat to marine wildlife because of ingestion, though. Toxic contaminants build up on the surface of plastic after prolonged exposure to seawater. When marine wildlife ingests plastic debris, toxic substances enter their digestive systems and accumulate in the food chain over time, affecting people who consume seafood. Globally, the economic cost of the negative impact of ocean plastic relative to marine natural capital is conservatively estimated at $3,300 to $33,000 per tonne of ocean plastic per year.[389]

382 Sathish, N., Jeyasanta, K. I., & Patterson, J. (2019). Abundance, characteristics and surface degradation features of microplastics in beach sediments of five coastal areas in Tamil Nadu, India. Marine pollution bulletin, 142, 112-118.

383 Nelms, S. E., Galloway, T. S., Godley, B. J., Jarvis, D. S., & Lindeque, P. K. (2018). Investigating microplastic trophic transfer in marine top predators. Environmental pollution, 238, 999-1007.

384 Imhof, H. K., Sigl, R., Brauer, E., Feyl, S., Giesemann, P., Klink, S., .. & Laforsch, C. (2017). Spatial and temporal variation of macro-, meso- and microplastic abundance on a remote coral island of the Maldives, Indian Ocean. Marine Pollution Bulletin, 116(1-2), 340-347.

385 Jang, Y. C., Hong, S., Lee, J., Lee, M. J., & Shim, W. J. (2014). Estimation of lost tourism revenue in Geoje Island from the 2011 marine debris pollution event in South Korea. Marine pollution bulletin, 81(1), 49-54.

386 Leggett, C. G., Scherer, N., Haab, T. C., Bailey, R., Landrum, J. P., & Domanski, A. (2018). Assessing the economic benefits of reductions in marine debris at Southern California beaches: a random utility travel cost model. Marine Resource Economics, 33(2), 133-153.

387 Convention on Biological Diversity. (n.d.). Impacts of Marine Debris on Biodiversity Current Status and Potential Solutions. CBD Technical Series No. 67 https://www.cbd. int/doc/publications/cbd-ts-67-en. pdf

388 Nash (1992). Impacts of marine debris on subsistence fishers: An exploratory study. Marine Pollution Bulletin, 24, 3, 150-156,

389 Beaumont, N. , Aanesen, M. , Austen, M. C. , Börger, T. , Clark, J. H. , Cole, M. T. , Hooper, T. , Lindeque, P. K. , Pascoe, C. , & Wyles, K. J. (2019). Global ecological, social and economic impacts of marine plastic. Marine Pollution Bulletin, 142, 189-195. https://doi.org/10. 1016/j. marpolbul. 2019. 03. 022

...adequate waste management is of paramount ecological and economic importance for the Maldives.

Furthermore, pesticides and heavy metals have been linked to impaired smell for fish, resulting in the inability to locate food. These hazardous substances can also build up in bottom sediments and contaminate shellfish and demersal finfish. In general, untreated wastewater and marine debris can cause developmental, reproductive, neurological, and immune disorders in both humans and wildlife. Hence, adequate waste management is of paramount ecological and economic importance for the Maldives.

Contaminated shellfish has been found to have several significant negative impacts. First, it affects a tourist destination's reputation and deters tourists from visiting. Second, shellfish contamination can lead to the closure of mussel fishing areas and the cessation of mussel businesses. The economic losses incurred by the shellfish industry due to reduced production, lost sales and damaged market reputation can be significant. Third, eating contaminated shellfish can lead to various health problems, including foodborne illnesses when contamination occurs through wastewater. This can result in higher healthcare costs as more people require medical assistance and treatment. The burden of healthcare spending falls on individuals, healthcare systems, and governments, placing an additional strain on resources and impacting the wider economy.

Photo Description: Plastic waste and other household residual waste dumped close to the coast on a inhabited Island, Maldives © World Bank

Historically, the development of waste and resource management infrastructure has been problematic in the Maldives. It has not been possible to provide engineered landfills on small islands that hardly project above sea level and the lack of financial and technical capacity has long prevented the development of more advanced waste management facilities. As a result, a central dumpsite was created at Thilafushi, near to the capital Malé, to which the majority of the country's waste has historically been transferred and dumped. The site opened in 1991 and grew into the "mountain" seen today. Operating standards were very low, with fires burning continually spreading smoke and toxic fumes over large areas near Malé. Waste being dumped at the site often spilled into the sea and leachate leaked from the waste "mountain" into the sea. Investments in expertise and infrastructure improvements to the site and its operation – stopping the burning, preventing spillage into the sea and operating the site using normal landfill equipment and in a phased way– have had significant impact on lessening these effects Figure 56 shows the change that has taken place at Thilafushi between January 2020 and March 2022.

Figure 56. The Thilafushi landfill has seen major improvements in recent years.

Thilafushi in January 2020 (left) and March 2022 (right)

Source: World Bank

As is the case in many non-high-income countries, the Maldives struggles to provide accurate and reliable solid waste data at the national level. The household waste generation rate is estimated at 412 kg/pp/yr or 1.13 kg/pp/day (based on a population of 498,000), which constitutes 47 percent of all waste.[390] However, it is recognized that inhabited islands generate much less waste per capita than residents of the capital city, Malé. The tourism sector is estimated to contribute 9 to 10 percent of all waste (based on an estimated generation rate per resort bed and the number of beds and an average bed occupancy rate derived from the 2021 Statistical Year Book).

The significance of the tourism sector and the increase in the number of tourists together with the consumption patterns and lifestyle changes of locals cannot be understated. The number of tourist beds increased from 24,816 in 2009 to 45,419 in 2018.[391] The average monthly household expenditure on food and beverages increased by 23 percent between 2016 and 2019.[392] This increase was larger in the atolls than in the Greater Male region. This, in turn, increases the logistical difficulties faced by the waste and resource management industry

390 UNESCAP. (2021). Maldives National Waste Accounts 2018 & 2019 Final Report. https://www.unescap.org/sites/default/d8files/2021-04/Maldives_National_Waste_Account_Report_2018-19. pdf

391 Maldives Bureau of Statistics (2022). Statistical Yearbooks 2010-2019. http://statisticsmaldives.gov.mv/yearbook/2022

392 Maldives Bureau of Statistics. (2019). Household Income and Expenditure Survey 2019. https://statisticsmaldives.gov.mv/hies-2019/

...tourism is seasonal, resulting in peaks and troughs in waste generation, adding to logistical difficulties.

and the potential for damage to both the terrestrial ecosystems and the coastal and oceanic in particular. By its nature, tourism is seasonal, resulting in peaks and troughs in waste generation, adding to logistical difficulties.

Construction and demolition (C&D) waste is the second largest waste stream by weight (42 percent of all waste). With limited levels of development, relatively small volumes of C&D waste are generated on inhabited islands. There is evidence that some is recycled but there is also mixing with household waste. With recent regulatory changes (see section below), the intention is that most C&D waste should be retained at the island level and recycled for further use. C&D is also generated during resort development and from developments in Malé and Hulhumalé, with recycling where practicable.

In addition to households and resorts, industries, including importers and exporters, also produce significant waste streams (see Table 8). These include fishing and agriculture (e.g., agricultural plots, fisheries, aquaculture); manufacturing (e.g., fish processing, boat building and repairs); water related services (e.g., sewerage, waste management); construction (e.g., resort construction, the significant residential and commercial developments taking place in); and transportation (e.g., sea and land transport and airport/aircraft maintenance). Hazardous waste is generated from empty pesticide containers and possibly from leftover pesticides. Other types of hazardous waste are waste oils, expired medicines, some types of e-waste, batteries, and empty containers of chemicals. There is no reliable data recording of the types and quantum of hazardous wastes generated. It is clear that hazardous wastes were mixed with municipal/household waste but attempts are now made to separate these.

2.4.1.1 Regulatory overview

There is no reliable data recording of the types and quantum of hazardous wastes generated. It is clear that hazardous wastes were mixed with municipal/household waste but attempts are now made to separate these.

Table 8. Waste generation by producer

Waste producer	2019 (est)(tons)	Relative share (%)
Construction	182,500	42%
Transport	3431	1%
Tourism	34,765	8%
Health	6,296	1%
Households	205,261	47%
Imports	542	0.1%
Total	432,795	100%

Source: World Bank 2017. Maldives Clean Environment Project

To reduce, minimize, and prevent adverse environmental impacts, a strong legislative and regulatory framework needs to be put in place, alongside institutional change. The GoM has implemented several policy changes and interventions in this regard in the past five years. An overview is provided in Table 9 below.

Table 9. Waste related policy interventions in the Maldives

Policy Name	Description	Year of Implementation
Single Use Plastic Phase-out Plan	A policy aimed at controlling the production, import, and consumption of certain single-use plastics and promoting sustainable alternatives.	2020
Ban Decree (2021/9)	A decree accompanying the Single Use Plastic Phase-out Plan that prohibits the production and sale of selected single-use plastics.	2021
5th Amendment to the Waste Management Regulation (2021/R-109)	Mandates the source separation of selected waste streams at the household level, promoting recycling, re-use, and recovery of household waste, including single-use plastic bottles.	2021
Waste Management Act (Law Number 24/2022)	A comprehensive legislation addressing waste management practices in the Maldives. It includes provisions related to plastic bag fees, waste separation, recycling, and other waste management aspects.	2022
Regulation on Collecting Plastic Bag Fee by Persons Registered for GST (2023/R-76)	Sets out rules and regulations for persons registered with the Maldives Inland Revenue Authority (MIRA) for Goods and Services Tax (GST) in collecting plastic bag fees as required by Chapter 8 of the Waste Management Act.	2023

Source: IOTC.

In January 2018, the Maldives EPA published the Maldives Marine Litter Action Plan, recognizing sustainable waste management as one of the biggest environmental challenges in the country. The problem has intensified in recent years due to population growth, changing consumption patterns, logistical difficulties in waste disposal, and limited availability of proper waste management facilities. Not only are land-based sources contributing to the litter, but sea-based sources also contribute to the presence of marine debris in Maldivian waters. While formal records are lacking, informal reports indicate that marine vessels, in close proximity to community islands, dispose of various types of waste such as plastics, polystyrene, rubber, wood, and metals into the ocean. The Action Plan assesses the social, economic, and environmental impacts of marine litter and highlights the legal instruments governing its management in the Maldives. It serves as a baseline for understanding the status of marine litter at the time of its development and provides valuable insights for future research and development in this area. Although the plan includes recommendations, there has been limited systematic implementation of the suggested actions, except for the progress made in developing laws and policies for solid waste prevention, minimization, and management. Additionally, it is important to note that the action plan does not encompass the most recent knowledge on plastic pollution and marine litter.

The Maldives Clean Environment Project, supported by the World Bank, includes an updated Action Plan for the Prevention and Management of Plastic Marine Litter. This plan is part of the project's Policy & Strategy component and provides guidance on national actions to be implemented between 2023 and 2027. The goal is to reduce and prevent plastic marine litter and mitigate its impact in the Maldivian Sea. The Action Plan addresses both land-based and sea-based sources of plastic litter and aims to address plastic litter that is already present in the marine environment. It emphasizes the importance of staying informed about the latest scientific findings and international efforts to combat marine litter and plastic pollution, with plans to update the Action Plan by the end of 2027. The overall objective is to minimize the ecological, human health, and economic consequences of plastic marine litter in the Maldives by eliminating problematic and unnecessary plastic products, adopting sustainable management practices for all products, resources, and waste, and reducing chemical hazards.

The Strategic Action Plan (SAP) of Maldives 2019-2023 serves as a crucial policy framework and planning document for the government. It sets the development direction for the country over a five-year period and focuses on five priority areas: Blue Economy, Caring State, Dignified Families, Jazeera Dhiriulhin (Island Life), and Good Governance. Within the SAP, Sector 1: Blue Economy and Sector 4: Jazeera Dhiriulhin are particularly relevant to this chapter. Jazeera Dhiriulhin encompasses sub-sectors that are significant for addressing Solid Waste Management (SWM) issues. This sector provides the necessary context and framework for advancing environmental protection efforts in the Maldives.

Under Sub-sector 4.4 of the Strategic Action Plan (SAP), the Utility Regulatory Authority (URA) was established through the URA Act (2020/26). The URA has a mandate that encompasses 39 responsibilities, with 10 directly related to SWM. This establishment of the URA resulted in a shift in the role of the EPA, with a majority of EPA staff being transferred to the URA. Consequently, the EPA now operates with a minimal staff capacity and limited experience, necessitating the urgent recruitment of new staff.

Current developments reflect a fundamental change to the approach to waste and resource management. Three key areas highlight this shift: the Single Use Plastic (SUP) Phase-out Plan, the requirement for source separation of discards, and the enactment of the Waste Management Act 2022. Plastic waste has been a critical issue in the Maldives, leading the government to introduce a SUP phase-out policy in 2020, accompanied by the Ban Decree 2021/9. Approximately 20,000–25,000 tons of plastic waste were produced in

The government has initiated a ban on the production and sale of selected single-use plastics, resulting in noticeable changes such as households replacing small PET bottles with large PET free water bottles, resorts transitioning from PET bottles to glass bottles, and increased awareness of plastic pollution issues.

the Maldives in 2018, with an estimated 1,500–2,000 tons entering Maldivian waters annually. The SUP phase-out plan involves controlling the production, import, and consumption of specific SUPs, as well as promoting sustainable alternatives. The initial action of the phase-out plan was implemented through the 18th Amendment to the Export-Import Act of Maldives on December 22, 2020. The government has initiated a ban on the production and sale of selected single-use plastics, resulting in noticeable changes such as households replacing small PET bottles with large PET free water bottles, resorts transitioning from PET bottles to glass bottles, and increased awareness of plastic pollution issues. These measures signify a significant step towards addressing plastic waste and promoting a more sustainable approach to waste management in the Maldives.

Furthermore, the Maldives has implemented the 5th Amendment to the Waste Management Regulation (2021/R-109). R-109 mandates the source separation of selected waste streams at the household level. This requirement aims to promote the recycling, re-use, and recovery of household waste, including SUP bottles. Both inhabited and resort islands are obligated to separate a minimum of four discard streams at the source.

Photo Description: A Dhoni loaded with segregated and baled recyclables, processed by the local community, off to be transported to recyclers and bring benefits back to the locals. Baa Atoll, Maldives © World Bank

Under the new Waste Management Act, the government has introduced various regulations, including the “Regulation on collecting plastic bag fee by persons registered for GST- 2023/r-76.” This regulation sets out the rules for persons registered with the Maldives Inland Revenue Authority (MIRA) for Goods and Services Tax (GST) in collecting plastic bag fees under Chapter 8 of the Waste Management Act (Law Number 24/2022). It also establishes regulations to enforce Chapter 8 of the Waste Management Act on applicable individuals or entities. The objective of this regulation is to effectively implement and enforce the provisions outlined in the Waste Management Act regarding the collection of plastic bag fees.[393]

Box 13. Waste Management Bill/Act

The upcoming Waste and resource management Bill[393] regards a very positive development towards a sound legal framework in the Maldives. The improvement / revision of the Bill is part of the present Technical Assistance (TA) assignment, and the respective Deliverable has been submitted on 13.6.2022. Two points are mentioned here:

- There is no clear mandate for the regional waste management centers
- No competent authority is assigned for hazardous waste management

Section 11 of the waste management bill gives the Ministry the mandate to establish operational waste management regional facilities and section 21 leaves it to a regulation to codify how this will be undertaken. Section 21 states “service providers of regional waste management services shall deliver their services according to the provider’s waste management operational plan formulated pursuant to the regulation made under this Act”.

A number of regulations, among these the hazardous waste regulation, are expected to be issued once the Waste Bill is published in the Official Gazette. The Regulation should ensure that hazardous waste should be promptly transported to regional centers instead of local handling them in the islands.

The remaining Regulations, and most important the one for the effective EPR mechanism, shall be prepared by the Ministry and be in line with the upcoming National Waste Management Plan. Moreover, as stated in the National Implementation Plan for the Stockholm Convention, “there is no dedicated institutional body mandated with the overall management of chemical substances, including Persistent Organic Pollutants (POP), in the Maldives. Furthermore, an analysis of the existing legislation within the scope of chemical regulation shows a lack of special legislative methodological base for POPs management. The responsibilities of management of hazardous chemicals, including POPs are distributed amongst various ministries, agencies and institutions. This has, consequently, led to fragmentation and a lack of effective coordination, impeding the realization of government policies towards the protection of the environment and human health from these substances.” This gap is expected to be solved with the development of the Chemicals Management Bill.

A late addition to the Bill was the provision to import waste and this was in the Bill as enacted. However, neither the President’s Office nor MoCCEE support this addition and moves are in hand to have it removed from the Act.

393 Not based on official translation of the bill.

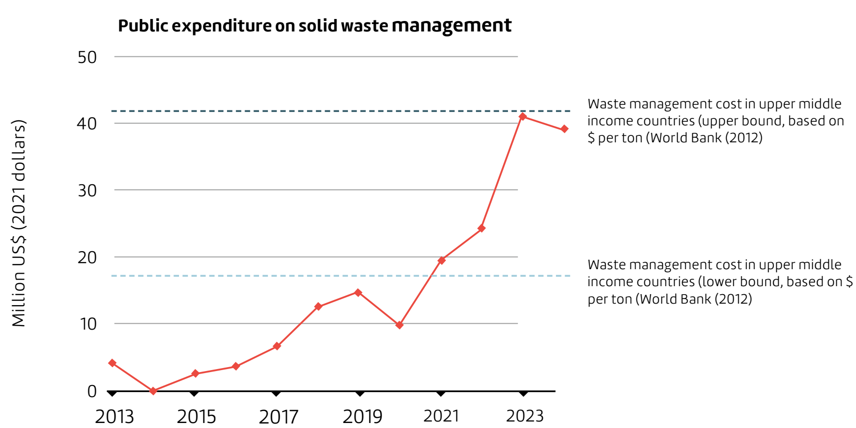
Currently, the GoM has successfully established 116 Island Waste Management Centers (IWMC) and Island Waste & Resource Management Centers (IWRMC), and progress is being made in establishing 3 Regional Waste Management Facilities (RWMF).

2.4.1.2 Current developments

The GoM has been actively investing in waste infrastructure and operational efforts to improve waste management. Currently, the GoM has successfully established 116 Island Waste Management Centers (IWMC) and Island Waste & Resource Management Centers (IWRMC), and progress is being made in establishing 3 Regional Waste Management Facilities (RWMF). The GoM has plans to expand the coverage of IWRMCs to all inhabited islands and upgrade IWMCs to IWRMCs as needed to comply with the requirements of the Waste Management Act for handling and processing recyclable waste streams. According to data from the Ministry of Finance, public expenditure on SWM has been increasing since 2014 (see Figure 57). As of 2021, it is comparable to the typical cost of waste collection and disposal in upper-middle-income countries. The graph below illustrates this upward trend in public expenditure. Additionally, significant future expenditure is anticipated, particularly after 2023, due to the funding required for major developments in the Greater Malé area and the Thilafushi Waste-to-Energy (WtE) plant.

Figure 57. Public expenditure on solid waste management has been increasing since 2014 and is now on par with other upper-middle income countries

Public expenditure on SWM between 2013 and 2023.



Source: World Bank based on the Ministry of Finance.

The GoM recognizes the importance of developing an Integrated Waste and Resource Management System (IWRMS) to address environmental damage to the marine environment and prevent the discharge of waste into the sea.

The GoM recognizes the importance of developing an Integrated Waste and Resource Management System (IWRMS) to address environmental damage to the marine environment and prevent the discharge of waste into the sea. This shift in approach is exemplified by the establishment of seven waste and resource management zones across the country, as depicted on the map in Figure 58. The Ministry of Environment has divided the Maldives into these distinct zones as part of the Saafu Raajje National Waste Management policy. The primary objective of this policy is to establish RWMC in each zone, along with an IWMC on every island. These initiatives align with the Decentralization

Act and the Strategic Action Plan, which outline the requirements for waste facilities and operations at the island level to manage locally generated waste. Additionally, the establishment of regional waste and resource management centers aims to meet more advanced waste management requirements. Zone 2, located in the North Central Region, was the first area to receive infrastructure development for SWM through the World Bank-supported Maldives Environmental Management Project (MEMP). This project, which took place from 2008 to 2016, focused on establishing a regional SWM program. It involved the creation and operation of IWMC on select inhabited islands and a RWMF on Vaadhoo Island in Raa Atoll. In 2017, the Maldives Clean Environment Project (MCEP), also supported by the World Bank, began. Building upon the achievements of MEMP, MCEP aims to further develop the regional components of the national Integrated Waste and Resource Management System (IWRMS). The project focuses on expanding facilities across Zone 2 and establishing new facilities in Zones 4 and 5. This includes the further development of the Vandhoo RWMF, the establishment of Island Waste & Resource Management Centers (IWRMC) in the three zones, and the upgrading of existing IWMCs where necessary. MCEP is involved in all stages of waste management, from the point of waste generation to collection, processing, marine transfer, and final disposal.

Figure 58. There are 7 waste and resource management zones across the country.

A map of the waste management zones and their individual

Source: World Bank

At the island level, Island Waste & Resource Management Centers (IWRMCs) are designed to receive and process source-separated discards, with a focus on maximizing recycling potential.

Given the Maldives' unique geographic makeup of atolls and islands, marine transfer is a key aspect of establishing regional and national integrated waste management systems. The Vandhoo RWMF comprises a 40-ton-per-day municipal waste incinerator with pollution control measures, a Waste-to-Energy (WtE) module for converting heat to electrical energy, and a hazardous waste landfill. Supporting infrastructure is also included in the facility.

In addition to MCEP, two other major regional projects support the development of the national IWRMS. In Zone 7, Addu City is undergoing a similar facility development, funded by the Abu Dhabi Fund for Development (ADFD). This facility features a 50-ton-per-day incinerator and is designed to handle residual waste from Zones 6 and 7. Construction is underway, and operations are expected to commence in 2024. The largest project is the Greater Malé Waste-to-Energy Project, supported by the Asian Development Bank (ADB). This project aims to establish a sustainable regional SWM system for the Greater Malé region and neighboring outer islands. It involves the construction of a 500-ton-per-day Waste-to-Energy plant and a landfill for hazardous waste disposal. Once operational in 2025, the Greater Malé facility will serve as the designated RWMF for Zones 4 and 5.

Photo Description: World Bank, Island Council and Project Teams working together- in Addu Maldives © World Bank

At the island level, Island Waste & Resource Management Centers (IWRMCs) are designed to receive and process source-separated discards, with a focus on maximizing recycling potential. Food and biodegradable waste, which typically constitutes 60-70 percent of an inhabited island's waste stream, is treated at the IWRMC through composting and/or anaerobic digestion. This process produces compost, biogas, and digestate that can be utilized on the

Many resorts have established "resource centers" away from guest areas to process collected source-separated materials for reuse, recycling, or transfer to third-party recyclers.

island, potentially generating revenue. In terms of plastic waste, plastic bottles are baled or bagged and collected for transfer to a recycling outlet. The NGO "Parley for the Oceans'' has been actively involved in PET bottle recycling in the Maldives, providing jumbo bags and collection services. They have processing centers in Malé and Thilafushi where PET bottles are containerized and exported to Taiwan for use in eco-friendly sportswear. Currently, much of this process is carried out at no cost.

Photo Description: Sunset in Maldives © World Bank

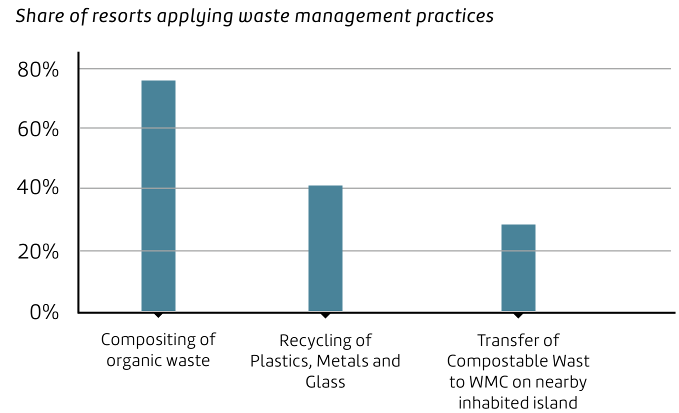
IWRMCs are equipped with glass crushers, allowing glass to be crushed and retained on the island for use in construction. Metals are generally baled and transferred to Thilafushi for recycling. Residual waste is collected from the islands and taken to the RWMF, where it may undergo further processing to remove contaminants before being fed into the incinerator. In some inhabited islands, cardboard is collected separately, baled at the IWRMC, and transferred to recyclers in Thilafushi who offer small payments for properly presented materials.

Many resorts have established "resource centers" away from guest areas to process collected source-separated materials for reuse, recycling, or transfer to third-party recyclers. Some resorts treat food and biodegradable waste to produce compost for use in growing fruits, vegetables, and herbs in their kitchens. Others utilize anaerobic digestion to produce biogas for cooking or generating electricity. Resorts may have agreements with drinks suppliers to return glass bottles for reuse. They also collect engine oils from generators and resort boats for recycling. The installation of solar panels to reduce or replace the use of diesel-powered generators is also becoming more common.

The majority of resort islands practice at least one form of sustainable waste management (see Figure 59). Specifically, 75 percent of resort islands practice composting of organic waste, while 41 percent engage in the recycling of plastics, metals, and glass. Compostable waste is commonly transferred to a Waste Management Center on a nearby island (28 percent).

Despite progressive improvements in waste and resource management, the practice of waste burning on many inhabited islands in the Maldives remains prevalent.

Figure 59. The majority of resort islands conducts at least one form of sustainable waste management



Source: World Bank & Ministry of Tourism led Environment and Climate Survey of Resort Islands (2023).

Despite progressive improvements in waste and resource management, the practice of waste burning on many inhabited islands in the Maldives remains prevalent. This is primarily due to the absence of viable alternatives until Island Waste & Resource Management Centers (IWRMCs) are established and reliable collection and transfer systems are in place. The government acknowledges the need to reduce and eliminate open burning and considers it a priority. Additionally, the lack of a proper transfer system from islands to regional centers has resulted in waste stockpiles accumulating on various islands. When these stockpiles become politically sensitive, the government must intervene. However, as the integrated system with IWRMCs and RWMFs is gradually implemented and regular collection schedules are established, this problem is expected to diminish.

A recent positive development involves greater involvement of Atoll Councils and a collaborative, atoll-level approach to improve the efficiency and cost-effectiveness of the waste and resource management system. In Zone 2, the participation of Atoll Councils is encouraged to enhance the utilization of specialized equipment. This can be achieved through consolidating specific material streams on an island or by scheduling the movement of equipment between islands. The NGO "Soneva Namoona" has played a significant role in this process, actively promoting source-separated recycling initiatives and awareness campaigns on islands in Baa and Noonu Atolls for several years. They are also considering expanding their activities to Raa Atoll. With the leadership and support from Soneva Namoona, their group of islands has achieved impressive results, with measured recycling rates as high as 90%, leaving only 10% residual waste. Notably, non-reusable diapers/nappies constitute a substantial portion of this residual waste by weight. These achievements and findings have substantial implications for the ongoing development of the Integrated Waste and Resource Management System, as further discussed below.

Box 14. Soneva Namoona Case Study

Soneva Namoona is an NGO that aims to empower zero-waste communities across the Maldives through innovations in zero-waste alternatives, recycling systems, and community empowerment. These innovations fall into three broad categories: Reduce (innovations in single-use plastic alternatives), Recycle (innovations in waste processing, infrastructure, and logistics), and Inspire (innovations in community empowerment and education). As of early 2023, Soneva Namoona works directly with eleven islands (seven in the Baa Atoll, three in Noonu atoll, and one in Haa Dhaalu) to co-create sustainable waste management systems.

Soneva Namoona engages with resorts and community islands based on the Namoona Sustainable Waste Management Model. The Namoona SWM Model reflects a concept for decentralized waste management that emphasizes the role of the people of small island communities. The Namoona SWM Model highlights household waste segregation and on-island waste collection as a critical first step. To create the necessary community buy-in and engagement, the Soneva Namoona team organizes door-to-door awareness-raising visits, community events at the Integrated Waste Management Center and engages with island leadership. On islands where Soneva Namoona is engaged, households are currently segregating between four and eight separate waste streams.

On four islands in Baa Atoll, the Soneva Namoona team implemented a Trial of Improved Practices (TIPs) research to better understand people's attitudes to primary segregation and their willingness to segregate more waste streams. TIPs method uses an approach where researchers and participants work together to assess the current situation, identify what needs improvement, choose trial solutions, and evaluate the trial experience to suggest possible changes. The TIP research showed household-level segregation practices existed in all four islands, though the levels of practice varied among islands. Most participants (82%, n=45) committed and successfully adopted the behaviors agreed during the TIPs. Most households were very positive and willing to continue waste segregation. In addition, most households did not ask for additional containers but were self-organized and creative in re-purposing containers.

Soneva Namoona also pursues opportunities to bundle waste processing and recycling services across islands. Considering the small size of Maldivian islands, the clustering of activities can increase efficiency and cost-effectiveness. For example, filling up a collection vessel with baled non-organic waste from one island takes several months. Along these lines, Soneva Namoona has been working to connect islands and to use one vessel to collect from four to seven islands at a time. In a recent recyclables collection, over 50 tons of recyclables were collected on a single Maldivian cargo boat from seven islands. The income generated from the sale of the recyclable materials covered the cost of transportation from the local islands to SN recycling partners. Soneva Namoona also conducted a pilot-test in which wood chipping machinery was shared across eight islands. They found that heavy-duty machinery could deal with green waste quickly and efficiently relative to smaller machinery. However, cost-effectiveness may become an issue when the machinery is not well utilized.

Sample segregation guide for households. Multi-island waste collection of baled recyclables.

Figure 60. A poster on waste segregation standards to guide the process.

Source: Fasgandu, Maldives Clean Environment Project

Figure 61. Multi-island waste collection of baled recyclables.

Source: Soneva Namoona, Maldives

Catering waste from international flights can be deemed potentially biohazardous in some countries due to animal health concerns. However, there is currently no local regulation in the Maldives categorizing catering waste as hazardous or special.

In addition to municipal waste, the handling and treatment of industrial waste, including hazardous and toxic materials, require careful consideration in the Maldives. While the country has designated industrial islands and some inhabited islands with small local industries, larger industries are concentrated in the Greater Malé area. The boat construction/repairing industry, fish processing, and airport/aircraft maintenance are among the prominent industrial activities in the Maldives. These industries generate various types of waste, including fiberglass, wood, metals, electrical components, glues, adhesives, sealants, and paint.

Currently, there are no reception facilities in the ports of the Maldives that are capable of accepting ship-generated waste, and there is no fee-charging system in place. This gap in infrastructure and service provision is a concern, considering that the Maldives heavily relies on sea transport for passenger and goods transportation between islands. This situation is in violation of the MARPOL convention developed by the International Maritime Organization (IMO) and ratified by the Maldives, which aims to prevent the disposal of shipborne waste into the sea.

The aviation sector also generates a significant amount of waste, considering the average of 384 flight movements per day.[394] Catering waste from international flights can be deemed potentially biohazardous in some countries due to animal health concerns. However, there is currently no local regulation in the Maldives categorizing catering waste as hazardous or special. Waste from local

394 Maldives-Magazine.com. (n.d.). Velana International Airport (MLE) - Maldives Magazine. https://maldives-magazine.com/general-info/velana-airport-mle.htm

aircraft maintenance activities includes oils, grease, paints, and packaging materials from spare parts. Furthermore, the airport must manage packaging waste and waste from imported products and customs activities.

The Waste Management Corporation (WAMCO) is the State-Owned Enterprise (SOE) responsible for providing waste management services in the Maldives. In Zone 3, which includes the Greater Malé area, WAMCO operates three transfer stations located in Malé, Villimalé, and Hulhumalé. It collects household waste from this area and transfers it by sea to the Thilafushi Waste Disposal Site. At Thilafushi, recyclables are processed, and residual waste is either deposited in the landfill or baled and stored until the new Waste-to-Energy (WtE) facility becomes operational. In the southern part of the country (Zones 6 and 7), WAMCO operates Waste Transfer Stations in Addu City Hithadhoo, Hulhumeedhoo, and Fuvahmulah City. It collects household waste from these areas as well.

For the Northern Region, WAMCO has a contract with the Ministry of Climate Change, Environment and Energy (MoCCEE) to operate the Vandhoo Regional Waste Management Facility (RWMF), the first of its kind in the country. However, the operation of this facility has faced challenges due to a lack of experience and expertise. It is expected to become fully operational by mid-2023. All the facilities mentioned above are located on islands and receive discarded materials from both inhabited and resort islands via marine transfer vessels operated by WAMCO.

Despite being the main public solid waste management operator, WAMCO faces ongoing financial difficulties and operates at a loss, particularly in rural areas where collection costs are high. It has limited resources in terms of vessels, vehicles, and technical staff. Some islands refuse to pay for poor collection services, and the institutional structure of WAMCO with multiple departments complicates budget management. Currently, WAMCO receives subsidies from the Ministry of Finance to offset its operating losses. It is crucial to conduct an assessment of WAMCO's realistic operating costs to explore options for increasing revenues (in line with polluter pays principles) and reducing subsidies.

The GoM recognized the importance of protecting the environment and addressing marine pollution by developing a strategy for a national integrated waste and resource management system. As part of this strategy, Island Waste & Resource Management Centers (IWRMCs) were mandated to be established on every inhabited island, and various measures were implemented on resort islands. The strategy also emphasized the need for regional disposal facilities and a well-managed marine transfer system to link these facilities effectively. In Zones 2, 3, 6, and 7, the responsibility for the transfer system was assigned to WAMCO. However, WAMCO's performance in providing regular, scheduled collection and transfer services has been unreliable, leading to delays in waste removal and resulting in some islands resorting to open burning or improper disposal practices. Island councils

A group of islands in Baa Atoll collaborated with the NGO Soneva Namoona to maximize recycling efforts at the island level and establish their own transfer system for recyclable materials.

in Zones 4 and 5, due to limited funding, face challenges in establishing a regular transfer system to transport waste to Thilafushi.

In response to these challenges, a group of islands in Baa Atoll collaborated with the NGO Soneva Namoona (see Box 14) to maximize recycling efforts at the island level and establish their own transfer system for recyclable materials. This approach focused on education, awareness, and active participation of island councils, women's groups, and islanders. It also ensured the availability of suitable equipment at the IWRMCs and implemented continuous monitoring and data collection. The results have been impressive, with recycling rates ranging from 60% to 70%. Recyclables are transported to Thilafushi using local supply dhonis, which are traditional vessels used for transportation between islands. This successful approach is being expanded to additional islands in Baa and Noonu Atolls, and there are plans for Raa Atoll to join this initiative soon.

Tailored solutions that consider local conditions have shown promising and sustainable outcomes.

Despite recent improvements in the waste sector, several key challenges persist:

- Lack of personnel with the necessary experience and technical qualifications to operate and manage waste facilities, logistics, and contracts. A comprehensive training regime is needed to develop the required expertise.
- Effective separation at source relies on a suitable collection system and a well-equipped and operating IWRMC.
- Adequate collection systems are essential for transferring material streams from IWRMCs to RWMFs, such as Thilafushi or recyclers.
- The governance, capacity, and systems for Inhabited Islands and Atolls are still evolving, and the (WAMCO faces its own organizational/logistics, financing, and capacity challenges.
- Implementing a proactive mentoring system at the inhabited island level, which educates and raises awareness, can encourage effective source separation and recycling initiatives while improving the local environment. Tailored solutions that consider local conditions have shown promising and sustainable outcomes.
- Poorly managed logistics, particularly in respect of a scheduled collections and transfer system between islands and RWMF (e.g.: Zone 2) leads island councils to doubt the value of IWRMCs and the integrated system approach.
- Insufficient funding at the island level prevents the effective operation of proposed systems. There is a large funding gap in MCEP preventing the full development of the planned infrastructure. Also, handing decentralized responsibility to island councils, the central government is not, as yet, providing adequate funding to operate an integrated system.

- Greater involvement at Atoll level can lead to improvements in cost-effectiveness and efficiency. MCEP has funded atoll coordinators in Zones 2, 4, and 5, to support the source-segregated approach mandated by GoM.
- Establishing links between inhabited islands and resorts can lead to mutual benefits, such as economies of scale, cross-subsidies from resorts, and resorts providing outlets for crafts made from recycled materials.

2.4.1.3 Waste pollution from the fisheries sector

At the global level, it is estimated that 20 percent of all plastic pollution found in the marine environment comes from marine sources, including fishing and fishing-related activities. Some studies estimated that some fishing gear can persist in the marine environment for up to 600 years, reflecting the lasting impact of abandoned, lost, or otherwise discarded fishing gear (ALDFG) on aquatic organisms, including fish, marine mammals, and seabirds.

However, the Maldives is a minor contributor to the total amount of ALDFG that enters the Indian Ocean. An estimated 9,531 metric tons of ALDFG per year enters the oceans from vessels from four countries alone (Bangladesh, the Maldives, Pakistan, and Sri Lanka).[395] The Maldives contributes only 0.3 percent of the gear lost at sea. Naturally, the Maldives' contribution to gear lost sea by all South-Asian countries will be even lower. The limited contribution of the Maldives can be attributed to the comparatively small fleet of the country. Furthermore, the country's fishing vessels are predominantly equipped with line gear, which is not only much lighter than nets but also less likely to be discarded intentionally.

Although the total weight of ALDFG attributable to Maldivian fisheries is very low compared to other countries, this low weight does not reflect the potential impacts on reef ecosystems. Monofilament lines are particularly dangerous and are widely used in the handline fishery (both reef and tuna fisheries) as well as in pole and line and recreational fishing. During dropline fishing activities targeting reef fish on the edge of the reef slope, sometimes the lines get tangled in the corals and are snapped as the fishers try to pull them out. On reefs where there is frequent fishing taking place, such incidents are more common and these lines can be seen stuck to the coral, potentially killing the polyps of corals.[396] The lines do not disintegrate and can be there for decades. These events happen mainly near populated islands, with fishing lines reportedly being lost particularly in the North Ari atoll (see Figure 62 and Figure 63). However, when considering all sources of waste in the fisheries sector, monofilament lines are a less acute threat to reef ecosystems than discarded gillnets from foreign vessels.

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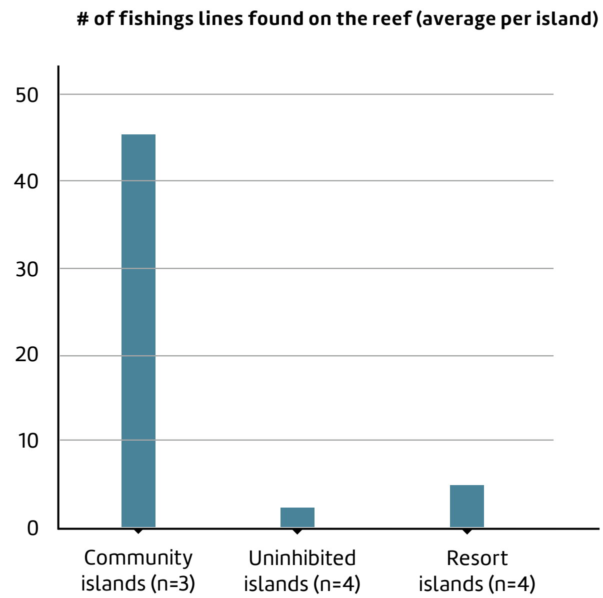
395 World Bank and the South Asia Water Initiative (SAWI). (2023). Baseline of Abandoned, Lost, or Otherwise Discarded Fishing Gear in South Asia: A Way Forward. Unpublished report.

396 Asoh et al. Damage to Cauliflower Coral by Monofilament Fishing Lines in Hawaii. Conservation Biology, 18, 6, 1645-1650.

Figure 62. Coral reefs near community islands are polluted with lost fishing lines

Number of fishing lines found in coral reefs in Maldivian islands in North Ari atoll.



Source: World Ban based on IUCN (2015)

Figure 63. Maldivian fishers frequently lose their line gear

Locations of lost fish gear (red dots) in the Maldives. Major port locations are indicated by orange dots.

Source: World Bank, 2023[397]

397 World Bank. (2023). Tangled Seas: A Snapshot of Abandoned, Lost, or Otherwise Discarded Fishing Gear in South Asia. Washington, DC: World Bank. Available at http://hdl.handle.net/10986/40362

As part of the Government's drive to reduce plastic usage, a plastic bags tax was recently introduced.

Addressing the challenges of sustainable waste management in the Maldives requires a careful balance between implementing realistic user fees and ensuring adequate funding, particularly considering the decentralized approach to waste and resource management at the local island level.

2.4.1.4 The role of fiscal policies in the waste sector

There are several taxes and charges in place in the Maldivian waste sector. At the island level, island Councils charge households for household collections and the costs of operating island waste centers. The level of fee is variable and determined by each individual council and is often related to what is considered affordable, rather than actual costs. On many islands, this charge is not mandatory, but households refusing to pay are required to take their own waste to the island waste center. If the Council has signed a contract with WAMCO for the collection and transfer of waste to a RWMF for processing and disposal, this cost is included in the monthly charge. In general, councils have insufficient funding to pay the full costs associated with waste and resource management, particularly the WAMCO component, resulting in Government subsidies either directly to the island council and/or to the loss-making WAMCO. As part of the Government's drive to reduce plastic usage, a plastic bags tax was recently introduced. Tax revenues from these two sources alone amount to an estimated US$ 39 per capita per year.[398] A tourist tax is in place that contributes to a "Green Fund" created in part to assist waste and resource management infrastructure development and operations. Differences in tax reporting make it challenging to compare this figure with waste taxes in other countries.[399]

Despite waste taxation being in place, the sector produces a range of environmental externalities. Solid waste is primarily shipped from the islands to the landfill in Thilafushi island. Generally, waste from Zones 1, 3, 6, and 7 ends up in Thilafushi. Waste from Zone 2 is generally taken to the Vandhoo RWMF. Waste leakage during transport from islands to Thilafushi is estimated to constitute 21 percent of national waste leakage.[400] Not all solid waste ends up being transported to Thilafushi, with an estimated 37 percent ending up in local waste disposal sites (particularly in Zones 4 and 5), and a small share is informally disposed of into the environment (1%) or burned (2%).[401]

Addressing the challenges of sustainable waste management in the Maldives requires a careful balance between implementing realistic user fees and ensuring adequate funding, particularly considering the decentralized approach to waste and resource management at the local island level. In the Maldives, where waste disposal services have been considered "free" or very low cost, achieving a realistic level of user fees can prove problematic. In the Maldivian

398 Own calculations based on actual revenues from waste disposal (in 2021) and expected revenues from the plastic bag tax (in 2022) (Budget in Statistics (Ministry of Finance (2022).

399 For example, the OECD estimated that Mauritius and Guyana in 2019 raised an estimated US$12-US$13 per capita for waste disposal, wastewater discharge, and pollutant emissions combined, but this may exclude some waste taxes that have not been labelled as such. Source: OECD 2023. Environmental taxation – OECD.

400 Royle, J. , Jack, B. , Parris, H. , Elliott, T. , Castillo, A. Z. , Kalawana, S. , Nashfa, H. , & Woodall, L. C. (2022). Plastic Drawdown: A rapid assessment tool for developing national responses to plastic pollution when data availability is limited, as demonstrated in the Maldives. Global Environmental Change-human and Policy Dimensions, 72, 102442. https://doi.org/10. 1016/j. gloenvcha. 2021. 102442

401 Maldives Bureau of Statistics 2019. Household Income and Expenditure Survey 2019. https://statisticsmaldives.gov.mv/hies-2019/

Developing funding arrangements that islanders can afford and that minimizes subsidies, is a key and urgent requirement

context, the Government has made waste and resource management a local, island-level responsibility, but without providing sufficient funding for the system being put in place. Developing funding arrangements that islanders can afford and that minimizes subsidies, is a key and urgent requirement. When assessing appropriate funding levels, it is necessary to recognize that setting fees at too high and unaffordable levels can be counter-productive, with householders potentially reverting to sea disposal, dumping, and open burning. The potential increase in illicit waste disposal caused by additional fees can be dealt with by rigorous anti-dumping enforcement. However, this may be feasible only in regions where waste sources are highly clustered, such as in the Greater Malé region. Enforcement may be too costly for islands outside these clusters because of their remoteness. Revenues generated by user fees help to sustain the upward trend in public expenditure on solid waste management infrastructure, which rose from US$ 4 million to US$ 24 million between 2013 and 2022.[402] Sustained investments are necessary to reduce waste leakage caused by inadequate waste management infrastructure. User fees also help confront households and businesses with the full cost of waste and resource management, including environmental externalities.

Plastic waste is a major threat to people and the environment, and several fiscal policies are in place that recognize this issue.

Plastic waste is a major threat to people and the environment, and several fiscal policies are in place that recognize this issue. It was estimated that 14 percent of the 43,134 tons of plastic waste produced annually is incinerated across the Maldives, leading to degraded air quality and associated health issues.[403] The Government of Maldives introduced several fiscal policies in an attempt to reduce plastic waste. In particular, an import tax on non-biodegradable plastic bags has led to a 76 percent reduction in plastic bag imports.[404] The import tax, introduced under the Export-Import Act (Act No. 31/79) in 2012, taxes non-biodegradable bags at a 400 percent rate. The plastics tax reduces demand for plastic bags by increasing their price but also by increasing consumer awareness of the environmental externalities of single-use plastics.[405] Next to the plastics tax, the Government of Maldives also has a single-use plastics ban in place that prohibits the import of a wide range of plastics, including drinking straws, Styrofoam lunch boxes, and PET beverage bottles. Furthermore, the new Waste Management Act requires businesses to charge a US$ 0.13 tax on plastic bags.[406] Finally, a Deposit Refund Scheme was tested in a pilot project funded by the UNDP's Smart City Initiative.[407] Deposit Refund Schemes incentivize consumers to participate in plastic bottle recovery. A deposit fee is charged upon purchase of the bottle and refunded when the bottle is returned. In the pilot project, single-use plastic water bottles were eligible for an Rf 1 refund if

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402 Ministry of Finance 2023. Budget in Statistics. https://www.finance.gov.mv/budget-in-statistics

403 Karasik, R. (2022). "Plastic Pollution Policy Country Profile: Maldives." NI PB 22-08. Durham, NC: Duke University

404 ibid.

405 Matheson. (2019). Disposal is Not Free: Fiscal Instruments to Internalize the Environmental Costs of Solid Waste in: IMF Working Papers Volume 2019 Issue 283 (2019)

406 PSM News. (2023). Businesses begin to levy fee on plastic bags. https://psmnews.mv/en/119720#:~:text=In%20late%202022%2C%20President%20Ibrahim,from%20April%2018%20this%20year.

407 Zero Waste Maldives. (2021, October 12). Rahdhu - Container Deposit Scheme - Zero Waste Maldives. https://zerowastemaldives.com/project/rahdhu-container-deposit-scheme/

returned to a designated collection point in Hulhumale'. The scheme collected 84 percent of the plastic bottles that it brought into the market. Similar Deposit Refund Schemes will be tested on other islands. Deposit Refund Schemes are an important way forward to improve waste collection, reduce waste leakage, and encourage recycling in the Maldives.

2.4.1.5 Recommendations

Short-term recommendations

The immediate priority is the establishment of a National Data and Information Registry. The registry should incorporate details of volumes and types of waste and discarded materials generated and collected, and the processes and outcomes in respect to material streams recycled and residual waste disposed. Accurate and timely data is an essential requirement when planning both infrastructure development and operating parameters. The tracking of waste is also essential to verify compliance and avoid unlawful practices. To meet this objective: (I) a weighbridge has been installed at the Thilafushi reception area; (ii) weighbridges are planned/being installed at the Vandhoo and Addu RWMFs; (iii) IWRMCs are being equipped with scales; and (iv) a relatively simple, KoboToolbox recording system has been rolled-out across inhabited islands. Resort islands have also started recording waste data.

Strengthen the decentralized waste management model by completing the infrastructure on the island and regional levels. So far, 112 IWRMCs have been constructed and are operational in the Maldives. The establishment of IWRMCs in all inhabited islands and the implementation of a proper logistics system for waste and material transfer need to be completed in a timely manner. This will allow efficient and cost-effective operation of the incinerators and WtE modules at the heart of the three RWMFs, currently in the place. The other special waste streams (e.g., batteries, e-waste, tires, vehicles), should be transferred by sea vessels to the Hazardous Regional Facility or the ELV dismantling workshop. For bulky waste such as furniture, a special pick-up service should be organized or be brought directly by the owner to the IWMC at a given time.

Increase the technical capacity and resources of the EPA to properly monitor and manage emerging issues, in particular microplastics. The current understanding of the prevalence of microplastics in coastal and marine ecosystems is very limited, despite indications that micro-plastics may pose a threat to the health of the country's ecosystems and people. There should be sufficient technical capacity at the EPA (see also Section 4.4) to determine the amount of microplastics present in the soil or sand through sampling and to develop a respective decision-support protocol.

I*ncrease the technical capacity and resources of the URA to efficiently and effectively license, monitor, regulate and carry out enforcement of an increasing* *number of facilities and levels of advanced technological infrastructure.* Currently, there is very limited in-country experience of the development and operation of the advanced waste and resource management technologies being established. Suitable training of Agency staff is urgently required.

Set concrete obligatory reuse and recycling targets for a growing range of discarded material streams and prioritize waste prevention. These targets should be set for both inhabited and resort islands, for the latter building on existing recycling targets as specified in the Fifth Tourism Masterplan (2023-2027). There are many good practices on source segregation implemented in the islands of the Maldives, through which recovery of clean compost and useful material could be well documented. Composting of organic waste is a natural process that is practiced globally for either low or medium/ large quantities and does not entail a high cost. Local composting will lower the sea transport costs and will also have a beneficial impact on the incineration plants, as the calorific value will increase. It should be noted that more recycling could make incineration uneconomic because it reduces the (calorific) volumes of residual waste. The commitment of the local citizens and the Councils will be a precondition to meeting the targets. Moreover, Policy 3 of SUP regards the Setting Reduction targets for plastic packaging. The present Policy sets quantitative targets for recycling which are realistic and achievable and will be reviewed towards the end of the planning period. Organics and material recycling, accompanied by incineration in the regional facilities that are currently under construction, will effectively promote waste reduction and minimize the need for landfill space.

Update the regulatory framework to facilitate the nation-wide introduction of an optimized user fee structure to mobilize the necessary resources for improving the country's waste management infrastructure. The collected user fees should be enough to cover the cost of waste collection and disposal. Better waste management will benefit key economic sectors as well as reduce the adverse impacts of pollution on people and the environment. Eliminating subsidies and introducing taxes on electricity can also generate revenues that can be used to reduce reliance on fossil fuels, including by improving the charging infrastructure for electric vehicles and investment in renewable energy sources. Notably, the Maldives has a high potential for solar energy with an average of 280 – 300 sunny days per year and a global horizontal irradiance (GHI) in the range of 2,000 – 2,050 kWh per m2 and year.[408]

Establish waste systems for healthcare and hazardous waste, developed to international standards. For hazardous waste, this will include an accurate database; safe, temporary storage at the point of generation; a specialist collection system; development of regional and/or national treatment facility(ies); and a national treatment and disposal facility.

408 World Bank. (2018). Solar Resource Atlas. https://globalsolaratlas.info/support/release-notes

Develop and implement a plan to eliminate the use of Single-Use Plastic Products (SUPPs) in resorts. The Fifth Tourism Master Plan (2023-2027) identifies the need for developing alternatives for SUPPS, recognizing that not all SUPPs can be eliminated. For the latter, a plan should be developed to manage the remaining SUPPS in ways that minimize negative impacts on the environment.

Medium-to long-term recommendations

Engage the private sector in waste management activities and simplify procedures for more efficient involvement. Both the public sector and private sector can address solid waste management in the Maldives and both options offer advantages and disadvantages. The most important merit of the private sector is flexibility and capital availability. Private sector involvement can also provide greater access to funding and reduce investment risk, as well as providing technology transfer and training to allow greater localization of the sector. It can also provide innovative approaches to solving local problems and raise standards more generally.

Establish a training regime for the waste and resource management sector, with an emphasis on technical training for the local Maldivian operators and technicians needed to operate and maintain equipment at IWRMCs and RWMFs. It should be noted that higher technical qualifications and international certification are required for staff working on incinerators, Waste-to-Energy modules and hazardous-waste landfills.

Develop sustainable waste management practices that are tailored to the archipelagic nature of the country. An example of where this has led to desirable outcomes is that of the Soneva Namoona initiative. The practices developed under this initiative approach can serve as a template for the other atolls and islands across the country. The wider adoption of these practices requires new institutional arrangements, including ensuring that there is a mandate to implement the sustainable waste management practices in other islands and to ensure continuity across the terms of consecutive island councils.

Increase citizen awareness, monitoring, and reinforcement of waste practices across the country. A fixed amount of the national budget should be reserved for investment in awareness campaigns through social media and school programs and to support a benchmarking platform that helps citizens evaluate and provide feedback to water, sanitation, and waste services providers. A citizen app was launched in 2016 as part of the Make My Island (UNDP) initiative to allow citizens to report illicit waste dumping in public areas. The reinforcement mechanism introduced by this platform should be rolled out to cover all islands, alongside community-based programs that offer incentives for participation and long-term monitoring. Appropriate waste management training such as composting and sorting waste is necessary.

Update and implement the 2018 Marine Litter Action Plan. The Action Plan should be updated to align with the UN 2030 Agenda for Sustainable Development and regional and international agreements related to plastics (e.g., the regional Marine Litter Action Plan for South Asian Seas Region 2019) and the national legislation, including plans already approved and/or enforced such as the "Single Use Plastics Ban Decree" and the "Single-Use Phase Out Plan."[409]

Explore Extended Producers' Responsibility (EPR) and Take-Back schemes. EPR is a policy instrument that makes producers responsible for products after their useful life. These schemes may be desirable for products with large environmental footprints, such as batteries, electronic equipment, and vehicles.

2.4.2 Free from runoff and liquid waste

Insufficient data collection and reporting hinders the stocktaking of wastewater management in the industrial, agricultural, and service sectors in the Maldives.[410,411] For example, obstacles are aggravated regarding chemical wastewater management in the Maldives, particularly due to the lack of comprehensive chemicals legislation and the fragmented institutional framework. However, efforts are being made to strengthen the legal framework, including draft legislation dealing with hazardous chemicals, such as the 'Hazardous Chemicals Management' Bill.[412] Yet, these sectors have significant potential to contaminate groundwater and surface water resources if appropriate measures for safe disposal and treatment of wastewater are not implemented. In the absence of data on these sectors, this section focuses mainly on domestic wastewater and sanitation.

The Maldives allocates about 0.8 percent of GDP (2017) to Water, Sanitation and Hygiene (WASH) projects.[413] In comparison, other SIDS have even lower allocations, such as Papua New Guinea (0.04 percent of GDP), Sao Tome and Principe (0.46 percent of GDP), and Vanuatu (0.012 percent of GDP). Fiji is an exception with a much higher allocation at 2.36 percent. This is in line with the findings of the UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) 2022 report, which highlighted that insufficient WASH funding was reported by over 75 percent of countries. Poor sanitation

409 Ministry of Environment, Climate Change and Technology. (2022). The "Consultancy Assignment for the Revision of National Waste Management Policy and Preparation of a National Waste Management Strategy" (MV-MEE-160547-CS-CQS). Report on the Existing Situation and Stakeholder Consultations (Deliverable 2).

410 Moosa, L. (2021). Maldives National Water Accounts 2018 & 2019. United Nations Economic and Social Commission for Asia and the National Bureau of Statistics, Maldives. https://www.unescap.org/sites/default/d8files/2021-04/Maldives_National_Water_Account_Report_2018-2019. pdf

411 ibid.

412 Ministry of Environment, Climate Change and Technology. (2023). Baseline Assessment on National Use of Chemicals and Associated Risks 2022. https://www.environment.gov.mv/v2/en/download/17999

413 Sanitationandwaterforall.org. (2020). State Of Water, Sanitation and Hygiene. Sanitation and Water for all. https://www.sanitationandwaterforall.org/sites/default/files/2022-04/SWA_Profile_Maldives_en. pdf

One of the key challenges in expanding water and sewerage access is the geographically dispersed nature of populated islands, which necessitates localized infrastructure projects and island-specific solutions.

is estimated to cause economic losses in excess of 4 percent of GDP in South Asia. This figure may be higher in the Maldives, where inadequate wastewater management can lead to the deterioration of the country's natural assets, which are the backbone of the economy.

One of the key challenges in expanding water and sewerage access is the geographically dispersed nature of populated islands, which necessitates localized infrastructure projects and island-specific solutions. Additional water storage capacity is needed, particularly in the atoll islands, to reduce the need for emergency shipments of water during the dry season. Adequate storage capacity will become increasingly important because droughts are expected to become more frequent due to climate change. Another challenge is the low population on several islands, where limited economies of scale may render the installation of large treatment facilities unprofitable for commercial utilities. Atolls with low populations may furthermore have limited technical capacity to operate water treatment facilities.[414] Recent progress has been made in this area by the United Nations Development Programme through the installation of rainwater harvesting infrastructure on several atoll islands.[415] Additional benefits of increased rainwater collection capacity include the reduced environmental impact of shipments of water to atoll islands and the reduction in plastic usage from bottled water.

Nevertheless, the Maldives has made great strides in providing basic sanitation services to its population. According to the Joint Monitoring Programme (JMP) data, nearly 100 percent of the population in the Maldives had access to at least basic sanitation services in 2020 (Figure 64). Basic services refer to the availability of improved facilities for the disposal of human excreta. These facilities are notionally not shared with other households but unsafely managed. In the Maldives, sanitation service levels have particularly improved in rural areas, with virtually all rural households having access to basic services as of 2020.

The level of sanitation in public buildings in the Maldives is limited. In particular, sanitation facilities are considered either limited (61 percent) or basic (39 percent) in these institutions.[416] Waste management coverage in these facilities is considered non-existent (22 %), limited (43 %) or basic (35 %).[417] This may be problematic since these buildings also include healthcare facilities, which produce considerable amounts of hazardous waste.

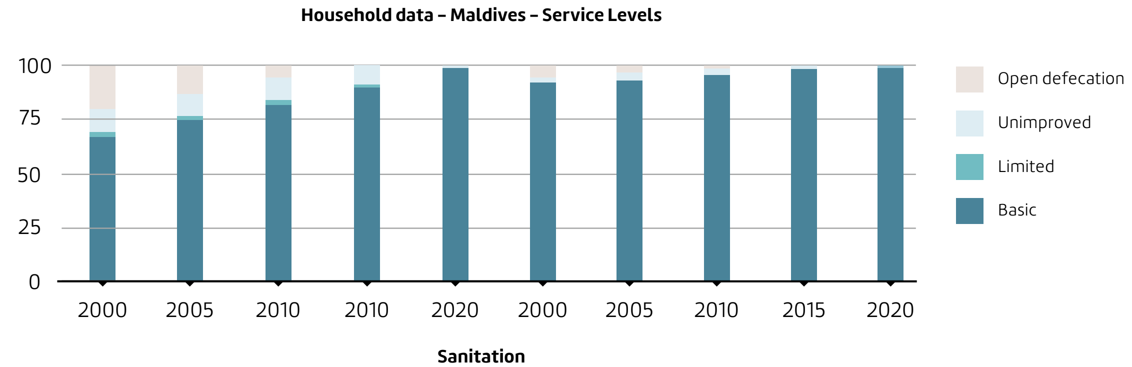
414 Ministry of Environment and Energy. (2017). National Water and Sewerage Policy (2017), Ministry of Environment and Energy, The Republic of Maldives, Malé.

415 United Nations Development Programme. (2021). Rainwater Harvesting Systems handed over to 8 islands of Maldives by Ministry of Environment with support of the Green Climate Fund, providing an additional 150 tonnes of water storage for the communities. https://www.undp.org/maldives/press-releases/improving-water-security-maldives-through-rainwater-harvesting

416 WHO/UNICEF (n.d.). Data. https://washdata.org/data/healthcare#!/dashboard/new

417 ibid.

Figure 64. Between 2000 and 2020, basic sanitation coverage expanded to virtually all Maldivian households and open defecation is hardly practiced as of 2020.



The sanitation service levels in the Maldives in rural and urban households between 2000 and 2020

Source: WHO and UNICEF (Joint Monitoring Programme Estimates on WASH), 2022

Sewerage coverage in Malé has continuously increased over the last decades, from 30 percent in the early 2000s to nearly 70 percent in 2020. In the atolls, the coverage is still much lower, with 48 percent of households being connected to a sewerage system, and 43 percent relying on a septic tank.[418] The sewer system in Malé started operating in 1988, and four years later, the sewerage schemes began working in the atolls with simplified systems, known as small bore sewerage systems. The effluent was collected from the onsite household sewage collection tanks and piped to near-shore marine outfalls, disposing of the untreated waste (see sections below for consequences on the environment).[419,420] The sector experienced some improvements with the establishment of systems such as conventional gravity sewers and vacuum sewers, which rely on external and national funding support mainly for the initial investment.[421] Information was not found regarding the reliance on external funding for the operation and maintenance of these systems or the capacity of locals for securing operations in the long-term.

While the number of sewer connections has continuously grown over the last decades, the share of wastewater that is treated has not increased by much. Many resort islands have sewage treatment plants (STPs). On local islands, there are 66 sewer systems currently established on local islands in the country. As of 2022, 15 sewage treatment plants (STPs) have been built, out of which 6 were in operational condition. The rest were not in use due to challenges in technical expertise and operational sustainability. Wastewater

418 Maldives Bureau of Statistics (2019). Household Income and Expenditure Survey 2019. https://statisticsmaldives.gov.mv/hies-2019/

419 MEE (2017). National Awareness Strategy for Water and Sewerage. Ministry of Environment and Energy, Malé, Maldives. http://www.environment.gov.mv/v2/wp-content/files/publications/20170716-pub-national-awareness-strategy-water-sewerage-mar2017. pdf

420 Private communications, February 2022.

421 MEE (2020). National Water and Sewerage Strategic Plan 2020-2025. Ministry of Environment and Energy, Malé, Maldives. https://www.environment.gov.mv/v2/en/download/10597

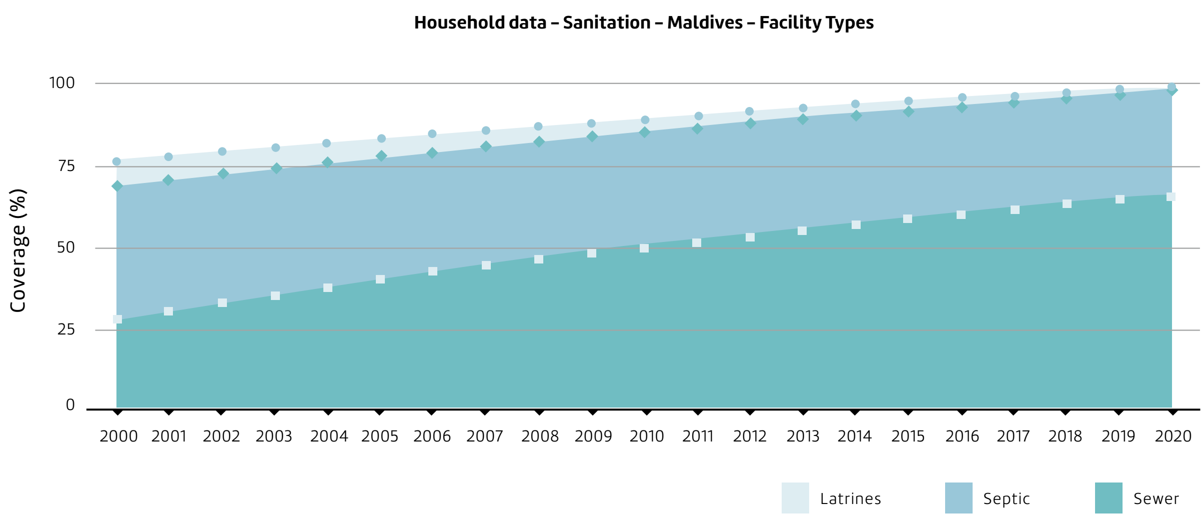
Steep population growth has led to a stark increase in sewage being discharged into the ocean without proper treatment. It is estimated that 15,000 m3 of sewage is discharged into the sea every day.

produced is bypassed untreated directly to the sea through marine outfalls, leading to ocean water pollution.[422] The Environmental Protection Agency in the National Wastewater Quality Guidelines (2007) defined a maximum allowable concentration of substances in domestic and industrial wastewater for deep sea discharge.

Steep population growth has led to a stark increase in sewage being discharged into the ocean without proper treatment.[423] It is estimated that 15,000 m^3 of sewage is discharged into the sea every day.[424] Similarly, much of the sewage and septage waste in atolls is not treated and is directly discharged either to the sea or on land. Domestic wastewater discharged into the deep Sea need to meet minimum standards set by the Maldives Water and Sanitation Authority (2007), including in terms of acidity, suspended solids, and maximum concentrations of E. Coli and Fecal coliforms.

Figure 65. Sewerage system coverage has been increasing continuously between 2000 and 2020

The coverage of sanitation facilities in the Maldives between 2000 and 2020.



Source: WHO and UNICEF, 2022.

The GoM is committed to achieving the UN SDG Goal 6 to provide "clean water and sanitation for all" and providing access to pipe water supply and pipe sewage services in all inner islands in the Maldives by 2023. To this end, the government planned to invest approximately 320 million USD by 2023 to provide water

422 Maldives Embassy in Germany (n.d.). Construction of Sewerage Treatment Plant in Male' City. https://www.maldivesembassy. de/blueeconomy/construction-of-sewerage-treatment-plant-in-male-city/

423 Personal communication with the public water utilities of the Maldives.

424 Maldives Embassy in Germany (n.d.). Construction of Sewerage Treatment Plant in Male' City. https://www.maldivesembassy. de/blueeconomy/construction-of-sewerage-treatment-plant-in-male-city/

Sewerage systems are available on 66 out of 187 inhabited islands, which covers about 77 percent of the population. The remaining islands are currently developing or planning their sewerage systems.

and sanitation facilities for all Maldivians on the 187 islands. 41 percent of the population had access to water supply systems and 48 percent had access to sewerage networks by the end of 2016.[425] The coverage of sewerage system has been steadily increasing from 2000 to 2020 (see Figure 65). Sewerage systems are available on 66 out of 187 inhabited islands, which covers about 77 percent of the population.[426] The remaining islands are currently developing or planning their sewerage systems.

2.4.2.1 Regulatory Overview

The EPA is responsible for monitoring and regulating the discharge of wastewater in the country.[427] The EPA sets standards and guidelines for wastewater treatment and discharge, conducts regular inspections and monitoring, and takes enforcement actions against violators. Under these regulations, all wastewater generators in the Maldives are required to obtain permits from the EPA before discharging wastewater into the environment.

The Utility Regulatory Authority (URA) is mandated to issue licensing, standards, and guidelines for water and wastewater service providers, and monitor compliance. The URA requires that domestic properties are connected to the public sewerage system, if present. Moreover, they require that all facilities such as manholes, collection chambers, lift stations, and sump wells shall be durable, leakproof and prevent any surface run-off /solids from entering the system and facilities. The septic tanks must also be inspected every two years by a licensed inspector.[428] Islands with sewer networks discharge their wastewater directly into the ocean, while islands with septic tanks release secondary-level treated wastewater back into the groundwater. Islands that have a functioning sewerage treatment plant in operation treat their wastewater before releasing it into the sea or using it for purposes such as landscaping.[429]

A water sewerage act was passed in 2020 to strengthen the legal framework to effectively regulate the water and sanitation sector in the country while encouraging investment from the private sector.[430] This Act differs from previous key regulations related to wastewater discharge and disposal in the

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425 Moosa, L. (2021). Maldives National Water Accounts 2018 & 2019. United Nations Economic and Social Commission for Asia and the National Bureau of Statistics, Maldives. https://www.unescap.org/sites/default/d8files/2021-04/Maldives_National_Water_Account_Report_2018-2019. pdf

426 Based on data from the MoE, URA, and service providers.

427 Zuhair, M. , & Kurian, P. (2016). Socio-economic and political barriers to public participation in EIA: implications for sustainable development in the Maldives. Impact Assessment and Project Appraisal, 34(2), 129–142. https://doi.org/10. 1080/14615517. 2016. 117640

428 Utility Regulatory Authority. (2021). General Guideline: Domestic Wastewater Disposal 2002-2021. Republic of Maldives; Available online: https://www.ura.gov.mv/downloads/general-guideline-domestic-wastewater-disposal-ura-20022021/

429 Moosa, L. (2021). Maldives National Water Accounts 2018 & 2019. United Nations Economic and Social Commission for Asia and the National Bureau of Statistics, Maldives. https://www.unescap.org/sites/default/d8files/2021-04/Maldives_National_Water_Account_Report_2018-2019. pdf

430 Sanitation and Water for all (2022) Maldives. https://www.sanitationandwaterforall.org/partners/countries-map/maldives (accessed on 10 December 2022).

The National Water and Sewerage Strategic Plan (2020-2025) emphasize the use of financially and environmentally sustainable technologies, strengthening the legal framework, capacity building, and raising awareness.

Maldives (the Water and Sewerage Act of 1995,[431] the Environmental Protection and Preservation Act of 1993,432 the Wastewater Management Regulations of 2008,433 and the National Water and Sewerage Policy of 2010[434]).

The governance and institutional framework for water and sewerage management in the Maldives is guided by the National Strategic Action Plan 2019-2023 (NSAP) and Clause 14(a) of the Water and Sewerage Act (8/2020). These provide the foundation for the development of the five-year National Water and Sewerage Strategic Plan (NWSSP 2020-2025). This plan aims to foster understanding and cooperation among government authorities, private enterprises, civil society, and external development partners to ensure effective implementation and financing. The NWSSP 2020-2025 aligns with the goals of the NSAP 2019-2023 and includes a mid-term review in the third year to assess progress, and identify achievements, challenges, and strategies for addressing them.[435] The Ministry of Environment takes the lead in implementing the NWSSP 2020-2025 and its policies, while the Water and Sanitation Department of the Ministry of Environment is responsible for implementing the Monitoring and Evaluation Framework. The NWSSP focuses on six main policies to promote equitable access to clean drinking water and improved sewerage facilities in all inhabited islands. These policies emphasize the use of financially and environmentally sustainable technologies, strengthening the legal framework, capacity building, and raising awareness. Research is also emphasized to support effective resource management in water and sewerage services.

In the Maldives, water and sanitation services are provided by state-owned, public, and private organizations. Fenaka Corporation is the largest service provider that covers the largest number of islands (56 islands), with four other service providers covering the other 10 islands.[436] Among these service providers is the Maleé Water and Sewerage Company, which services more than half of the population. The company is 80 percent owned by the Maldivian government and 20 percent owned by the Hitachi company.

The National Wastewater Quality Guidelines (NWWQGs) were developed in 2007 and the Maldives Water and Sanitation Authority (MWSA) is the authority to administer the guidelines. The principal objective of this Guideline is to provide clear technical guidance to manage domestic and industrial

431 Maldives Legal Information Institute (MLII) (n.d.). Water and Sewerage Act. https://www.environment.gov.mv/v2/en/download/11340

432 Maldives Legal Information Institute (MLII) (n.d.). Environment Protection and Preservation Act of Maldives Law No: 4/93. (n.d.). https://en. unesco.org/sites/default/files/maldives_act_11_08_1998_engl_orof. pdf

433 EPA. (2008). The Wastewater Management Regulations of 2008. https://www.epa.gov.mv/wastewater-management-regulations-2008/

434 MEE. (2010). The National Water and Sewerage Policy of 2010. http://www.environment.gov.mv/v1/wp-content/uploads/2017/01/National-Water-and-Sewerage-Policy-2010.pdf

435 MEE (2020). National Water and Sewerage Strategic Plan 2020-2025. Ministry of Environment and Energy, Malé, Maldives. https://www.environment.gov.mv/v2/en/download/10597

436 Moosa, L. (2021). Maldives National Water Accounts 2018 & 2019. United Nations Economic and Social Commission for Asia and the National Bureau of Statistics, Maldives. https://www.unescap.org/sites/default/d8files/2021-04/Maldives_National_Water_Account_Report_2018-2019. pdf

Pollution caused by poorly managed human excreta, agricultural runoff, and industrial effluents is affecting groundwater reserves, surface water resources, marine ecosystems, food webs, and biodiversity.

wastewater effluents while following international best practices in terms of cleaner operations and production. The guidelines also deal with domestic wastewater quality for discharge into the deep sea and provide the maximum concentration of listed components that must be complied with at all times, including coliform, pH, and suspended solid levels.

The NWWQGs provide maximum concentration levels for domestic and industrial wastewater combined but do not provide specific guidelines for industrial effluents or leachates of any kind. Moreover, because the wastewater discharges from solid waste management operations fall under the categorization of industrial effluent and leachate, the NWWQGs do not present specific standards for those discharges.[437] The temperature of the discharge is not mentioned, which is a relevant consideration due to the effect on marine ecosystems.

The EPA has established specific guidelines for the management of healthcare facility wastewater in the country.[438] Some of the key guidelines include that healthcare facilities must obtain permits from the EPA before discharging any wastewater into the environment. Healthcare wastewater must be treated with appropriate technologies, such as membrane bioreactors, activated sludge systems, or oxidation ponds, and regularly monitored.

In 2021, the URA published the General Guideline for Domestic Wastewater Disposal, which among others, provides information about general provisions, general requirements, consent, and treatment requirements. The Guideline also features a series of regulations for septic tank and soak-away construction, operation, and maintenance.[439]

2.4.2.2 Environmental impacts of inadequate sanitation and waste management

Pollution caused by poorly managed human excreta, agricultural runoff, and industrial effluents is affecting groundwater reserves, surface water resources, marine ecosystems, food webs, and biodiversity.[440] A notable example is the decline in the condition of reefs surrounding 43 resort islands, which has been attributed to increased nutrient levels from untreated sewage discharge.[441] This discharge has also been found to contaminate the tissue of Maldivian

437 MEE (2016). Maldives Clean Environment Project Environmental and Social Assessment and Management Framework (ESAMF) & Resettlement Policy Framework (RPF). Ministry of Environment and Energy, Malé, Maldives. https://www.fao.org/faolex/results/details/en/c/LEX-FAOC172921/

438 EPA (2012). Guidelines for the Management of Healthcare Facility Wastewater in the Maldives. https://www.epa.gov.mv/wp-content/uploads/2017/01/Health-Care-Facility-Waste-Water-Management-Guidelines.pdf

439 Utility Regulatory Authority (2021). General Guideline: Domestic Wastewater Disposal 2002-2021. Republic of Maldives; Available online: https://www.ura.gov.mv/downloads/general-guideline-domestic-wastewater-disposal-ura-20022021/ (accessed on 11 December 2022)

440 Hutton, G. , & Chase, C. (2017). Water Supply, Sanitation, and Hygiene. In The World Bank eBooks (pp. 171–198). https://doi.org/10.1596/978-1-4648-0522-6_ch9

441 Price, A. R., & Firaq, I. (1996). The environmental status of reefs on Maldivian resort islands: a preliminary assessment for tourism planning. Aquatic Conservation: Marine and Freshwater Ecosystems, 6(2), 93–106.

Wastewater effluents can lead to significant degradation of mangrove greenbelts, coral reefs, and seagrass beds. During extreme events, like storms and floods, discharges of wastewater can lead to so-called "wastewater tsunamis".

corals, potentially inhibiting coral growth,[442] particularly when combined with elevated ocean temperatures.[443] However, the impacts of wastewater on aquatic life and ecosystems remain poorly understood in the Maldives, despite being extensively studied in other regions.

In coastal areas, wastewater runoff is considered a "slow hazard", which can be greatly intensified by natural disasters. Wastewater effluents can lead to significant degradation of mangrove greenbelts, coral reefs, and seagrass beds.[444] During extreme events, like storms and floods, discharges of wastewater can lead to so-called "wastewater tsunamis". Floods caused by heavy rainfall frequently occur across the Maldives.[445] Given the frequent occurrence of floods resulting from heavy rainfall in the Maldives, coastal ecosystems are at constant risk of degradation due to wastewater contamination.

Sediments deriving from the deposition of (sewage) waste in the tourism and fisheries sectors may have significantly contributed to the growth of seagrass beds.[446,447] However, chronic high concentrations of dissolved nutrients can lead to excessive algal growth, reducing the amount of light reaching seagrass beds.448 Mangrove ecosystems in the Maldives are also threatened by sewage waste, which can impede their growth rates.[449]

Desalination practices may affect mangroves, too. The existing method of water desalination has proven effective in providing freshwater.However, due to its negative impact on the environment–including high energy consumption and highly concentrated saltwater waste– it is becoming increasingly controversial. The effects of extreme hypersalinity on mangroves in both temperate semi-arid and subtropical semi-arid regions are comparable. Globally, hypersalinity has caused mangrove diebacks.[450] For example, desalination sewage harms the vegetative features of young mangrove plants. The detrimental effects on the vegetation characteristics increase as the concentration of desalination

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442 Heikoop, J. M., Risk, M. J., Lazier, A. V., Edinger, E. N., Jompa, J., Limmon, G. V., .. & Schwarcz, H. P. (2000). Nitrogen-15 signals of anthropogenic nutrient loading in reef corals. Marine Pollution Bulletin, 40(7), 628-636.

443 Hughes, T.P., Baird, A.H., Bellwood, D.R., Card, M., Connolly, S.R., Folke, C., Grosberg, R., Hoegh-Guldberg Jackson, J.B.C., Kleypas, J., Lough, J.M., Marshall, P., Nyström, M., Palumbi, S.R., Pandolfi, J.M., Rosen, B., Roughgarden, J., 2003. Climate change, human impacts, and the resilience of coral reefs. Science 301, 929–933.

444 Cochard, R. (2017). Coastal water pollution and its potential mitigation by vegetated wetlands: An overview of issues in Southeast Asia. Redefining Diversity & Dynamics of Natural Resources Management in Asia, Volume 1, 189-230.

445 MEE (2019). Environmental and Social Impact Assessment (ESIA) for the proposed sewage treatment plant in Hulhumale. https://files.epa.gov.mv/file/1523.

446 Miller, M. W., & Sluka, R. D. (1999). Patterns of seagrass and sediment nutrient distribution suggest anthropogenic enrichment in Laamu Atoll, Republic of Maldives. Marine Pollution Bulletin, 38(12), 1152–1156.

447 ibid.

448 Mandura, A. (1997). A mangrove stand under sewage pollution stress: Red Sea. Mangroves and Salt Marshes, 1(4), 255–262. https://doi.org/10. 1023/a:1009927605517

449 Pawar, P. R. (2013). Monitoring of impact of anthropogenic inputs on water quality of mangrove ecosystem of Uran, Navi Mumbai, west coast of India. Marine Pollution Bulletin, 75(1–2), 291–300. https://doi.org/10. 1016/j. marpolbul. 2013. 06. 045

450 Dittmann, S. , Mosley, L. M. , Stangoulis, J. C. R. , Nguyen, V. T. , Beaumont, K. P. , Dang, T. A. , Guan, H. , Gutierrez-Jurado, K. Y. , Lam-Gordillo, O. , & McGrath, A. (2022). Effects of Extreme Salinity Stress on a Temperate Mangrove Ecosystem. Frontiers in Forests and Global Change, 5. https://doi.org/10. 3389/ffgc. 2022. 859283

Algal bloom events may have contributed to the documented mass fish kills in 2007, 2008, and 2012, which resulted in large numbers of fatalities for reef-dwelling fish, such as triggerfish and surgeonfish.

sewage increases. The consequences of hypersalinity extend beyond mangrove trees and affect the entire mangrove ecosystem. Degradation and loss of mangroves result in a reduction in biodiversity, particularly in species endemic to mangroves, as well as a reduction in plant biomass and soil organic carbon. Therefore, it is recommended to minimize damage to mangrove forests by the adequate use of desalination and sewage removal techniques.[451]

Increased nutrient input in marine waters potentially contributes to fish mortality in the Maldives. Algal bloom events may have contributed to the documented mass fish kills in 2007, 2008, and 2012, which resulted in large numbers of fatalities for reef-dwelling fish, such as triggerfish and surgeonfish.[452,453] This is because algae blooming leads to the depletion of oxygen and the increase of toxic metabolites, resulting in mass mortality of fish and other marine animals.[454] Farmers often apply fertilizer at higher concentrations than manufacturers recommend, and runoff can increase nitrogen, phosphorus, and other nutrient levels in the marine environment, affecting marine biodiversity. Improper use can also degrade soil quality and contaminate groundwater.[455] Many problems related to chemical use have been identified, including pest resistance due to overuse of pesticides, poor awareness and monitoring by farmers, and resistance to switching to safer alternatives and organic pesticides. Certain unacceptable practices have also been reported, including the use of pesticides not intended for specific products, the general use of mixed pesticides in lieu of nutrient treatments, and the continued use of prohibited pesticides. Farmers demonstrated some knowledge of the risks involved but lacked information on specific hazards. Currently, oversight to ensure safe handling and use of chemical pest control products is required.

The lack of proper sewage and waste management also contributes to the presence of harmful emerging contaminants, which negatively affect aquatic organisms. Aquatic organisms can be negatively affected by chemicals from sewage discharges, especially near sewage treatment plants,[456,457] however the magnitude and extent of this issue remains unknown in the Maldives. As far as waste leakage is concerned, chemical substances, such as birth control medications, and daily consumption substances, such as caffeine, can cause

451 Behrouzi Khorgou, S., Parvaresh, H., Moslehi, M., & Khalil Ariya, A. (2022). Effects of desalination sewage on some vegetative characteristics of gray mangrove seedlings (Avicennia marina Forssk. Vierh). Iranian Journal of Forest, 14(3), 329-340.

452 Dhunya, A., Huang, Q., & Aslam, A. (2017). Coastal habitats of Maldives: status, trends, threats, and potential conservation strategies. Int J Sci Eng Res, 8, 47-62.

453 S. Naeem, S. , & Sattar, S. A. (2007). A Compilation of Reported Fish Kills in the Maldives. Marine Research Center. Ministry of Fisheries, Agriculture and Marine Resources. http://www.mrc.gov.mv/assets/Uploads/2007-A-Compilation-of-Reported-Fish-Kills-in-the-Maldives. pdf.

454 Anderson, D.M., Glibert, P.M., Burkholder, J.M., 2002. Harmful algal blooms and eutrophication: nutrient sources, composition, and consequences. Estuar. Coast. Shelf Sci. 25 (4b), 704–726.

455 Ministry of Environment, Climate Change and Technology. (2023). Baseline Assessment on National Use of Chemicals and Associated Risks 2022. https://www.environment.gov.mv/v2/en/download/17999

456 Sumpter, J. P. (2005). Endocrine disrupters in the aquatic environment: an overview. Acta hydrochimica et hydrobiologica, 33(1), 9-16.

457 Pait, A. S. (2002). Endocrine disruption in fish: An assessment of recent research and results. https://aquadocs.org/handle/1834/19994

To ensure a holistic approach, it is essential to integrate the management of wastewater and freshwater resources.

reduced male fish sizes and reduced fish reproduction potential.[458] Chemical contamination has been reported near a landfill on Magoodhoo island (Faafu),459 but there is no national-scale data on this issue.

There is an overall lack of comprehensive wastewater and treatment systems in the Maldives, and few recently constructed resorts have such facilities. After the 2004 tsunami, loans from multilateral development banks and support from donor organizations facilitated the construction of sewage systems with basic treatment measures such as gravel bed filters and vacuum systems. Unfortunately, the interplay between the increasing scarcity of freshwater as a result of climate change and the possibility of wastewater recovery and reuse is currently not considered. Therefore, it is crucial to establish a link between wastewater treatment planning and long-term freshwater availability. To ensure a holistic approach, it is essential to integrate the management of wastewater and freshwater resources. Failure to make this link will reduce the effectiveness of adaptive rainwater harvesting and groundwater management initiatives to mitigate climate-related risks. Prioritizing proper wastewater management planning is imperative to mitigate potential hazards and build overall climate resilience in the region.[460]

Antimicrobial resistance (AMR) has emerged as a major global threat affecting humans, animals, and the environment, primarily due to the irresponsible overuse of antibiotics in agriculture, human medicine, and livestock. Poor WASH practices can lead to the spread of infectious diseases, which in turn leads to increased use of antibiotics. Lack of consistent wastewater treatment exacerbates the spread of antibiotic-resistant bacteria as wastewater from homes, hospitals, industries, and farms contaminates natural water sources, as well as soil and crops.[461] AMR therefore leads to the emergence and spread of multidrug-resistant bacteria that can cause infections that cannot be treated with current antibiotics. No information about AMR predominance in the Maldives has been found. However, it is known that the lack of a proper sewage system aggravates AMR, which reduces the effectiveness of antimicrobial therapy and increases the incidence, severity, and cost of infection.[462] This is of particular concern for the Maldives because wastewater is not safely managed in the majority of households and healthcare facilities.

458 Niemuth, N. J., & Klaper, R. D. (2015). Emerging wastewater contaminant metformin causes intersex and reduced fecundity in fish. Chemosphere, 135, 38-45.

459 Rizzi, C., Seveso, D., Galli, P., & Villa, S. (2020). First record of emerging contaminants in sponges of an inhabited island in the Maldives. Marine Pollution Bulletin, 156, 111273.

460 UNDP. (n.d.). Adaptation Fund. https://www.adaptation-undp.org/sites/default/files/downloads/approved_proposal_maldives. pdf

461 WHO. (2017). Water, Sanitation and Hygiene: An essential ally in a superbug age. https://www.who.int/southeastasia/news/opinion-editorials/detail/water-sanitation-and-hygiene-an-essential-ally-in-a-superbug-age

462 Velazquez-Meza ME, Galarde-López M, Carrillo-Quiróz B, Alpuche-Aranda CM. (2022). Antimicrobial resistance: One Health approach. Vet World. 15, 3, 743-749.

2.4.2.3 Recommendations

Short-term recommendations

Plan a wastewater monitoring framework. Due to the limited availability of information and reliable data in the Maldives, it is crucial to establish an environmental monitoring system for both domestic and industrial wastewater facilities (see also Section 4.4). The initial step is to conduct a baseline survey that includes information on the sources and quantity of wastewater, the types of treatment systems in use, and the quality of treated wastewater. The survey should also evaluate the social and environmental implications of wastewater control practices. Local specialists and citizen science can be utilized for data collection. Additionally, modern low-cost tracking technology should be employed for data collection, after learning from the experiences of other SIDS. It is essential to involve wastewater utilities, companies, users, and other stakeholders in the planning of the new data collection framework. By doing so, the Maldives can ensure that the collected data is comprehensive and represents the needs and opinions of all relevant parties. To study the impact of wastewater on human health, it is important to set a baseline and determine the levels of contaminants in the water. By conducting extensive assessments and monitoring, identifying key contaminants, and prioritizing areas of high health risk would be possible to address wastewater effects on human health. These risks can be effectively mitigated by developing concrete solutions, such as advanced treatment technologies. Moreover, addressing immediate health problems would be feasible if resources are also granted to vulnerable communities and high-density areas. Eventually, continuous monitoring and evaluation will ensure the effectiveness of implemented actions, resulting in improved water quality and improved overall health outcomes.

Include aquatic ecosystems and bioindicators in the monitoring framework. Wastewater discharge can adversely affect the health of aquatic ecosystems and species, including coral species (see Section 2.1.1.1). However, the scale and extent of this problem in the Maldives are still unknown. Given the significance of Maldives' aquatic ecosystems to both the local community and the tourism industry, it is imperative to conduct a comprehensive study as a basis for management. It is equally important to maintain up-to-date records to track any changes. This dataset should evaluate, at a minimum, the concentration and distribution of chemicals originating from wastewater discharges in water, sediments, and the tissues of aquatic organisms in the Maldives. A more comprehensive evaluation should also identify the particular chemicals present in the wastewater and their toxicity on aquatic organisms. Over time, this data will provide valuable information to policymakers and other stakeholders to better understand the risks associated with sewage discharges and to develop and adjust wastewater management strategies to protect the health of aquatic ecosystems in the Maldives.

Prioritize investments in improved wastewater collection, treatment, and disposal on each inhabited island. Some inhabited islands, particularly those with small populations, currently lack proper means of collecting, treating, and disposing of wastewater. The priority of each island depends, among other things, on the local impact on aquatic ecosystems, the island population size, and the systems currently in place. The prioritization should be informed by a robust Strategic Environmental Assessment (see Section 4.5).

One potential approach to mitigate the contentious impacts of desalination on the mangrove ecosystems of the Maldives involves exploring new scientific discoveries and technologies. For example, the addition of Vibrio alginolyticus bacteria can decrease salinity levels by approximately 40 percent.[463]

Medium-to long-term recommendations

Enhance wastewater management planning to sustain both natural and human systems in the archipelago. It is crucial to establish a sewer system capable of handling the anticipated rise in tourism arrivals.[464] The Maldives needs a comprehensive wastewater management plan that covers all aspects of the cycle, including collection, treatment, and disposal. This plan should not only encompass households but also address the wastewater generated by various industries operating in the country. Wastewater management planning must account for the projected increase in tourist arrivals and its impact on different stages of the cycle. Additionally, as the Maldives develops plans to accommodate tourism growth, it is imperative to consider wastewater management during periods of fluctuating volume and seasonal changes in tourism.

Provide the population with sufficient information on the proper management of wastewater and promote the use of best practices in resource-use planning. This can help prevent hazards and threats to the water supply and sewage systems that may arise from maladaptive development. In the Maldives, sharing knowledge among youth, school children, educators, businesses, and the industry about the best ways to protect and manage water resources can lead to behavioral changes at the individual and community levels. For effective wastewater management in households and industries, accessible and transparent public information is crucial. However, for information to be shared, it must first be collected, gathered, and analyzed following consistent standards. Due to the lack of comparable information, it is important to establish a baseline and gather qualitative and quantitative data about wastewater treatment and disposal at the household and industry levels.

Establish a comprehensive system for managing chemical-related incidents, particularly addressing the underdeveloped chemical wastewater management at the industrial level. The current chain of command for handling such

463 Chimayati, R. L. (2019). Removal of Salinity using Interaction Mangrove Plants and Bacteria in Batch Reed Bed System Reactor. Journal of Ecological Engineering, 20(4), 84–93. https://doi.org/10. 12911/22998993/102792

464 Leoni, B., Zanotti, C., Nava, V., Rotiroti, M., Stefania, G. A., Fallati, L., .. and Bonomi, T. (2021). Freshwater system of coral inhabited island: Availability and vulnerability (Magoodhoo Island of Faafu Atoll–Maldives). Science of The Total Environment, 785, 147313.

incidents is unclear, involving several agencies in response efforts. To enhance effectiveness, it's imperative to integrate and harmonize current approaches, where different stakeholders create their own response plans, ensuring a unified response to chemical spills, fires, and toxic events. In this context, the accelerated development of national chemical accident, fire, and poison response plans is highly recommended to improve coordination between authorities. Additionally, to mitigate the risk of pesticides or an excessive amount of nutrients in the water masses of the Maldives, it is suggested to conduct awareness campaigns, such as the Project for Developing Sustainable Agricultural Economy (PDSAE) and Good Agricultural Practices (GAP),[465] along with implementing regular monitoring questionnaires.[466]

Improve financial data collection in the water and sanitation sector. Developing sustainable financing strategies for the water and sanitation sector involves considering financial data from various sources such as taxes, tariffs, transfers, and estimated household expenditure. However, the government's financial information is incomplete as it lacks budget data, state/provincial expenditure, local government expenditure, and reliable revenue estimates for drinking water and sanitation. The public financial management system is also weak as complete annual financial reports and financial management information are not available. Additionally, public reporting does not allow for the integration of personnel and payroll data. Furthermore, some of the largest donors do not report on their use of country procurement systems, country financial management systems, and support for strengthening sector systems/capacity.

Explore opportunities at the intersection of economic development and environmental conservation. For example, a study on the availability and vulnerability of freshwater in Magoodhoo Island in the Faafu Atoll[467] suggests that constructed wetlands could be a sustainable solution for wastewater treatment while reducing the over-exploitation of groundwater. In these systems, pollutants are removed by the wetland vegetation, soils, and their associated microbial assemblages to improve water quality.[468] Prerequisites for pursuing these opportunities could require additional funding for wetland conservation, such as from the Green Fund (Section 3.2.2) and enhanced legal protection of wetlands (see Section 3.1).

Freshwater is defined as any naturally occurring liquid or frozen water resource which is non-saline and contains less than 500 parts per million of total dissolved solids. Freshwater can be located in groundwater aquifers or

465 United Nations Development Programme. (n.d.). Project for Developing Sustainable Agricultural Economy (PDSAE) to increase food security.https://www.undp.org/maldives/projects/project-developing-sustainable-agricultural-economy-pdsae-increase-food-security

466 Ministry of Environment, Climate Change and Technology. (2023). Baseline Assessment on National Use of Chemicals and Associated Risks 2022. https://www.environment.gov.mv/v2/en/download/17999

467 Leoni, B., Zanotti, C., Nava, V., Rotiroti, M., Stefania, G. A., Fallati, L., .. & Bonomi, T. (2021). Freshwater system of coral inhabited island: Availability and vulnerability (Magoodhoo Island of Faafu Atoll–Maldives). Science of The Total Environment, 785, 147313

468 Ghermandi, A., Van Den Bergh, J.C.J.M., Brander, L.M., De Groot, H.L.F. and Nunes, P.A.L.D. (2010) Values of natural and human-made wetlands: a meta-analysis. Water Resour. Res., 46, pp. 1-12, 10.1029/2010WR009071

Islands with low populations may have ample unpolluted freshwater supplies, but groundwater quality has deteriorated on many populated islands due to the over extraction of groundwater, saltwater intrusion, improper disposal of wastewater, and disposal of solid wastes on land.

in surface water such as lakes, reservoirs, ponds, rivers, streams, freshwater wetlands, and glaciers. The primary source of freshwater in the Maldives is groundwater. Mangroves and saltwater wetlands are common in the Maldives, particularly in the Northern Atoll Islands, but the country contains no surface water freshwater.[469]

Photo Description: Clear blue waters of the Lagoon at Maanagala, Maldives © World Bank

Pollution of groundwater has rendered many sources of groundwater unusable for human consumption. Islands with low populations may have ample unpolluted freshwater supplies, but groundwater quality has deteriorated on many populated islands due to the over extraction of groundwater, saltwater intrusion, improper disposal of wastewater, and disposal of solid wastes on land. As a result, potable water sources in the Maldives include primarily rainwater harvesting, desalinated water, and bottled water. Groundwater is still used, however, by most households for non-potable purposes. Households in atoll islands outside of Malé increasingly rely on rainwater harvesting for potable water needs, however, treatment of rainwater through boiling or chemicals before use is minimal.

2.5. Fresh Water Supply

2.5.1 Groundwater

Groundwater in atoll islands is found in a layer of freshwater known as a freshwater lens, which floats on top of a denser layer of sediments that

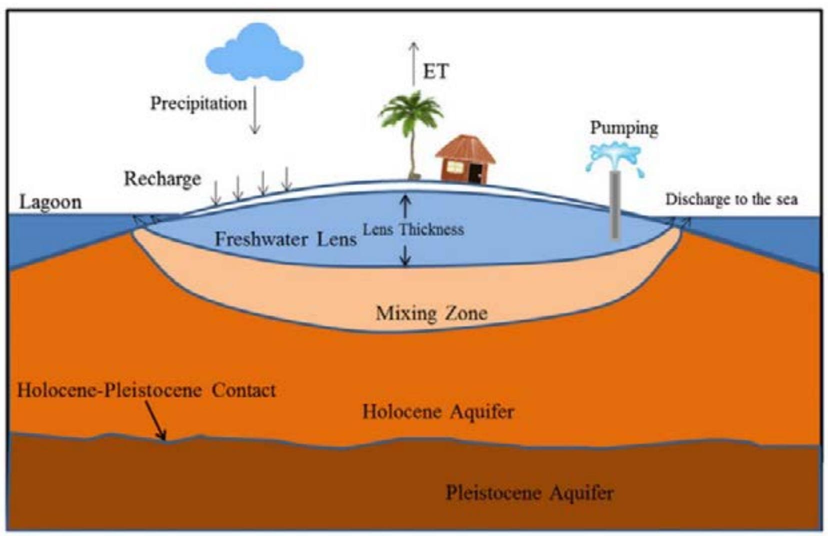
469 Stevens, G. V. G. , & Froman, N. (2019). The Maldives Archipelago. In Elsevier eBooks (pp. 211–236). https://doi.org/10. 1016/b978-0-08-100853-9. 00010-5

Freshwater lenses are recharged through rainfall, and as such, can vary in thickness due to seasonal rainfall variability in the short term and changes in precipitation resulting from climate change in the long term.

are saturated with seawater. Figure 66 shows a cross-sectional diagram of a typical freshwater lens of atoll islands. Freshwater lenses are recharged through rainfall, and as such, can vary in thickness due to seasonal rainfall variability in the short term and changes in precipitation resulting from climate change in the long term.[470] The average thickness of freshwater lenses varies considerably between islands. Smaller islands of 200 meters wide have an average freshwater lens thickness of less than one meter deep, and larger islands of 1,100 meters wide have an average lens thickness of nearly 12 meters deep.[471]

Figure 66. Atoll islands have a freshwater layer below the island surface

A typical freshwater lens of atoll islands



Source: Adopted from Deng and Bailey, 2017 [473]

The low elevation of much of the country makes it extremely susceptible to intrusion of saltwater into the freshwater lens when regions become inundated.

The low elevation of much of the country makes it extremely susceptible to intrusion of saltwater into the freshwater lens when regions become inundated. Approximately 75 percent of the Republic of Maldives is less than 1.5 meters above average sea level (see Section 2.3). Furthermore, freshwater lenses in the Maldives are particularly vulnerable due to their shallow depth of 1 to 1.5 meters below the ground surface on average.[474]

470 Bailey, R. C. , Khalil, A. F. , & Chatikavanij, V. (2014). Estimating transient freshwater lens dynamics for atoll islands of the Maldives. Journal of Hydrology, 515, 247–256. https://doi.org/10. 1016/j. jhydrol. 2014. 04. 060

471 Chenda, D. & Bailey, R.T. (2017). Assessing groundwater availability of the Maldives under future climate conditions. Hydrological Processes 31.19, 3334–3349

472 Deng, C. & Bailey, R. T. (2017). Assessing groundwater availability of the Maldives under future climate conditions. Hydrological Processes 31 (19). https://doi.org/10.1002/hyp.11246

473 ibid.

474 Ministry of Environment and Energy, (2017). State of the Environment Maldives 2016. In Male: Ministry of Environment and Energy, The Republic of Maldives, Malé. https://www.environment.gov.mv/v2/en/download/4270

Per capita renewable water resources in the Maldives from groundwater have decreased from nearly 300 m3 per inhabitant per year in 1964 to 55 m3 per inhabitant per year in 2020.

Per capita renewable water resources in the Maldives from groundwater have decreased from nearly 300 m3 per inhabitant per year in 1964 to 55 m3 per inhabitant per year in 2020.[475] The decline in freshwater resources per capita is largely due to population growth in the Maldives. Per capita freshwater resources in the Maldives are significantly lower than the average of SIDS in 2020 of 27,423 m^3 per inhabitant per year.[476] Bailey et al. (2015) estimate a per capita safe yield of 300 liters/day of groundwater, which is expected to decrease by approximately 34 percent by the year 2030 due to increases in population and shoreline recession.[477]

The 2004 tsunami resulted in saltwater intrusion into the freshwater lens reservoirs in many outer islands, resulting in brackish water.[478] Climate change projections indicate that the Maldives is expected to experience an increased frequency of similar natural disasters. The frequency of extreme sea level flooding events is projected to increase 100-fold by 2100 in the Maldives at a warming of 1.5 degrees Celsius or higher over the baseline period of 1980–2014.[479] Man made coastal modifications such as sand mining and land reclamation may also increase vulnerability to severe storms.[480] Furthermore, climate change threatens coral health in the Maldives, which is the nation's natural defense against ocean storm surges.

Groundwater contamination from sewage is a primary contributor to freshwater lens pollution. In addition to pollution from sewage systems, infiltration of untreated wastewater into the ground and solid wastes on land also contribute to groundwater pollution. Much of the pollution from sanitation results from leaks from poor sewage infrastructure with onsite septic tanks being a primary contributor of pollution from sanitation.[481] Leaks and overflow from septic tanks may also be exacerbated by flooding events.[482] In Malé, nearly all households have household toilets connected to a sewerage system, but only 26 percent of households have sewerage connections in the atolls. In administrative atoll islands, 11 percent of households have toilets connected to the sea, and 63 percent of households have toilets connected to onsite septic

475 AQUASTAT | Land & Water | Food and Agriculture Organization of the United Nations | Land & Water | Food and Agriculture Organization of the United Nations. (n.d.). https://www.fao.org/land-water/databases-and-software/aquastat/en/

476 AQUASTAT | Land & Water | Food and Agriculture Organization of the United Nations | Land & Water | Food and Agriculture Organization of the United Nations. (n.d.). https://www.fao.org/land-water/databases-and-software/aquastat/en/

477 Bailey, Ryan T., Abedalrazq Khalil, and Vansa Chatikavanij. (2015). "Estimating current and future groundwater resources of the Maldives." JAWRA Journal of the American water resources Association 51.1: 112-122.

478 Acciarri, M.F. et al. (2021). Water Resource Management and Sustainability: A Case Study in Faafu Atoll in the Republic of Maldives. Sustainability 13.6, 3484.

479 Tebaldi, Claudia, et al. (2021). "Extreme sea levels at different global warming levels." Nature Climate Change 11.9: 746-751.

480 Disaster Management Reference Handbook - Maldives (May 2021) - Maldives. (2021, May 11). ReliefWeb. https://reliefweb. int/report/maldives/disaster-management-reference-handbook-maldives-may-2021

481 Ministry of Environment, Climate Change, and Technology. (2021). A guide to groundwater improvement measures in small low-lying islands of the Maldives. Malé. Ministry of Environment, Climate Change, and Technology.

482 Ministry of Environment and Energy, (2017). State of the Environment Maldives 2016. In Male: Ministry of Environment and Energy, The Republic of Maldives, Malé. https://www.environment.gov.mv/v2/en/download/4270

A gravity sewer system combined with proper wastewater treatment is the ideal system in terms of environmental and health benefits, but these systems are often considerably costly and many islands in the Maldives do not have functioning wastewater treatment plants.

tanks.[483] A gravity sewer system combined with proper wastewater treatment is the ideal system in terms of environmental and health benefits, but these systems are often considerably costly and many islands in the Maldives do not have functioning wastewater treatment plants.[484] Instead, many islands currently pump untreated wastewater into the ocean, which can have significant impacts on ocean and coral health (see Section 2.5).

Table 10. Groundwater indicators in selected islands[485]

Water quality parameters	Water quality standards	B. Hithaadhoo	Hithadhoo, Addu City	Gn. Fuvahmulah	Ga. Dhekanbaa
pH	6.5 - 8.5	8.0	7.5	7.6	8.8
Electrical Conductivity (μS/cm)	<1000 μs/cm (maximum allowable) 300 - 700 μs/cm (recommended)	1108.3	824.7	687.8	1725.6
Salinity parts per thousand (‰)	<0.5 ‰ (maximum allowable) 0.15 - 0.35 ‰ (recommended)*	0.9	0.5	0.3	12.6
Percentage of samples with positive faecal coliforms (%)	0%	100	60	100	100
Faecal Coliform counts (CFU/100ml)	0 CFU/100ml	97.0	59.0	54.0	45.5

Source: Adapted from Second National Communication of Maldives, October 2016, Ministry of Energy and the Environment to the United Nations Framework Convention on Climate Change. Water quality standards are from the Utility Regulatory Authority of the Maldives. *Range is for total dissolved solids

Groundwater resources in the Maldives are contaminated. Table 10 presents groundwater indicators on selected islands in the Maldives. Most samples contain detectable levels of fecal coliform. Any detectable fecal coliform levels in a 100ml water sample do not meet World Health Organization guidelines for safe drinking water.[486] A pH value of 6.5 to 8.5 is considered within the acceptable range of product water according to the Utility Regulatory Authority of the Maldives.[487] However, the high pH of the groundwater samples presents concerns because chlorine water disinfectants become ineffective at pH level

483 National Bureau of Statistics. (2016). Maldives population and housing census 2014; Statistical release: V1 Housing and household characteristics. Malé, Maldives. National Bureau of Statistics, Ministry of Finance and Treasury. http://statisticsmaldives.gov.mv/nbs/wp-content/uploads/2016/07/Statistical-Release-IV-Housing-FINAL. pdf

484 Ministry of Environment and Energy, (2017). State of the Environment Maldives 2016. In Male: Ministry of Environment and Energy, The Republic of Maldives, Malé. https://www.environment.gov.mv/v2/en/download/4270

485 Ministry of Environment and Energy. (2016). Second national communication to the United Nations framework convention on climate change. Malé. Ministry of Environment and Energy. https://unfccc. int/sites/default/files/resource/SNC%20PDF_Resubmission.pdf

486 Water, Sanitation, Hygiene and Health. (2021). A global overview of national regulations and standards for drinking-water quality, 2nd ed. www.who. int. https://www.who. int/publications/i/item/9789240023642

487 Desalination Plant Registration Application. (2022, October 13). Utility Regulatory Authority. https://www.ura.gov.mv/downloads/desalination-plant-registration/

In addition to contamination from fecal coliform, groundwater is often highly saline.

of 8 or higher.[488] The burden of diarrheal diseases resulting from consumption of untreated water sources in the Maldives remains high. Diarrheal disease is among the top 5 causes of hospital admissions for children in the Maldives and constitute between 3 and 4 percent of total hospital admissions among children under 14 years of age.[489] The government continues to prioritize sewerage access to reduce groundwater contamination and cholera epidemics, and by 2017, 48 percent of the population had access to household sewerage connections.[490]

In addition to contamination from fecal coliform, groundwater is often highly saline. Electrical conductivity is an indicator of total salinity. Maximum electrical conductivity standards in the Maldives are 1000 μS/cm, and water with electrical conductivity of less than 700 μS/cm is considered safe for drinking.[492] Table 10 suggests that groundwater is not safe for drinking due the presence of fecal coliform and/or the high salinity of the groundwater. Freshwater is defined as having a salt concentration of less than 500 mg/L (see Table 11) and is typically considered safe for drinking. However, slightly saline water with a salt concentration up to 1,500 mg/L may potentially be used for irrigation. Further saltwater intrusion into the freshwater lens has the potential to damage agricultural crops with deep roots such as mango and banana trees, which also have low salt tolerance.[493]

Table 11. Water Classification and Salinity

Water Classification	Electrical Conductivity (μS/cm)	Salt Concentration (mg/L)	Uses
Non-saline	<700	<500	Drinking water, irrigation
Slightly saline	700-2,000	500-1,500	Irrigation
Saline	2,000-45,000	1,500-35,000	
Brine/Seawater	>45,000	>35,000	

Source: Adapted from FAO (1992)[492]

Household perceptions of groundwater quality in the Maldives is also poor. In a household-level survey conducted across 45 inhabited islands of the Maldives, Jaleel et al. (2020) find that survey respondents report groundwater

488 World Health Organization. (2021. A global overview of national regulations and standards for drinking-water quality, second edition.

489 Maldives Health Statistics. (2020). Ministry of Health Republic of Maldives. https://health.gov.mv/storage/uploads/BkoMELod/utbdxbkp. pdf

490 National Water and Sewerage Policy – August 2017. (2023, June 12). Your Site NAME Goes HERE. https://www.environment.gov.mv/v2/en/download/5880

491 Rhoades, J. D. , Kandiah, A, Mashali, A. M. (n.d.). The use of saline waters for crop production FAO irrigation and drainage. Food and Agriculture Organization of United Nations, Rome. No. 48, 1992. https://halophyteskh. biosaline.org/sites/default/files/content/MarginalResources_MWater/FAO48. pdf

492 Environmental Protection Agency. (2020). Water Quality Data. https://en.epa.gov.mv/news/24

493 Ministry of Environment and Construction. (2004). State of the Environment Maldives 2004. https://www.preventionweb.net/files/617_SoEMaldives2004.pdf

An open question is whether the quality of the groundwater in the Maldives can potentially be restored to allow potable use for households with wells or to be used for irrigation of agricultural crops.

that is contaminated and saline.[494] While few respondents reported using the groundwater for cooking (up to 15 percent) and drinking (less than 2 percent), more than 90 percent of respondents across all surveyed islands reported use of groundwater for non-potable purposes. Treatment of groundwater through boiling or the use of chemicals at the household level was also found to be rare.[495] In 2019, an estimated 23 million tons of groundwater was abstracted by households, compared to only 550 thousand tons of rainwater collected.[496]

An open question is whether the quality of the groundwater in the Maldives can potentially be restored to allow potable use for households with wells or to be used for irrigation of agricultural crops. Significant steps must be taken to prevent further pollution and salinization of groundwater as this water is still being used by households for non-potable purposes. However, increased severity of storms combined with sea level rise due to climate change further threatens the prospects of recovery of groundwater in the Maldives.

In 2020, it is estimated that more than 99 percent of households in the Maldives had access to basic water and sanitation (see also Section 2.4.2). This is significantly higher than the average of basic water and sanitation access for SIDS of 83 percent and 68 percent, respectively.[497] Groundwater has historically been the primary source of water in the Maldives, with rainwater collection beginning in the 1930s, and desalination starting in the 1990s.[498] Rainwater is the main source of drinking water on the administrative atoll islands, with 76 percent of households using rainwater, 19 percent using bottled water, and 5 percent using desalinated water (see Figure 67). However, most of the rainwater used is not treated at the household through boiling, filtering, or chlorination.[499] Rainwater is considered to be an unsafe source of water if untreated as it is affected by atmospheric pollution from the Indian subcontinent.[500] In Malé, however, most drinking water is from improved sources: 79 percent from bottled water and 21 percent from desalinated sources. As of 2017, 41 percent of the population had access to improved water supplied through commercial utility companies.[501] The government of Maldives aims to provide piped water to all households and eliminate dependence on groundwater and bottled water.

494 Jaleel, M. I. , Ibrahim, S. A. , Hussain, A. , Mustafa, M. O. , & Pathirana, A. (2020). A Screening Approach for Assessing Groundwater Quality for Consumption in Small Islands: Case Study of 45 Inhabited Islands in the Maldives. Water, 12(8), 2209. https://doi.org/10. 3390/w12082209

495 ibid.

496 Moosa, L. (2021). Maldives National Water Accounts 2018 & 2019. United Nations Economic and Social Commission for Asia and the National Bureau of Statistics, Maldives. https://www.unescap.org/sites/default/d8files/2021-04/Maldives_National_Water_Account_Report_2018-2019. pdf

497 WHO/UNICEF. (n.d.). Joint Monitoring Programme (JMP) for Water Supply and Sanitation. https://washdata.org/

498 Hosterman, H. , & Smith, J. (2015). Increasing Climate Change Resilience of Maldives through Adaptation in the Tourism Sector. Tourism Adaptation Project. (TAP). https://archive. tourism.gov.mv/downloads/publicaltions/Economic. pdf

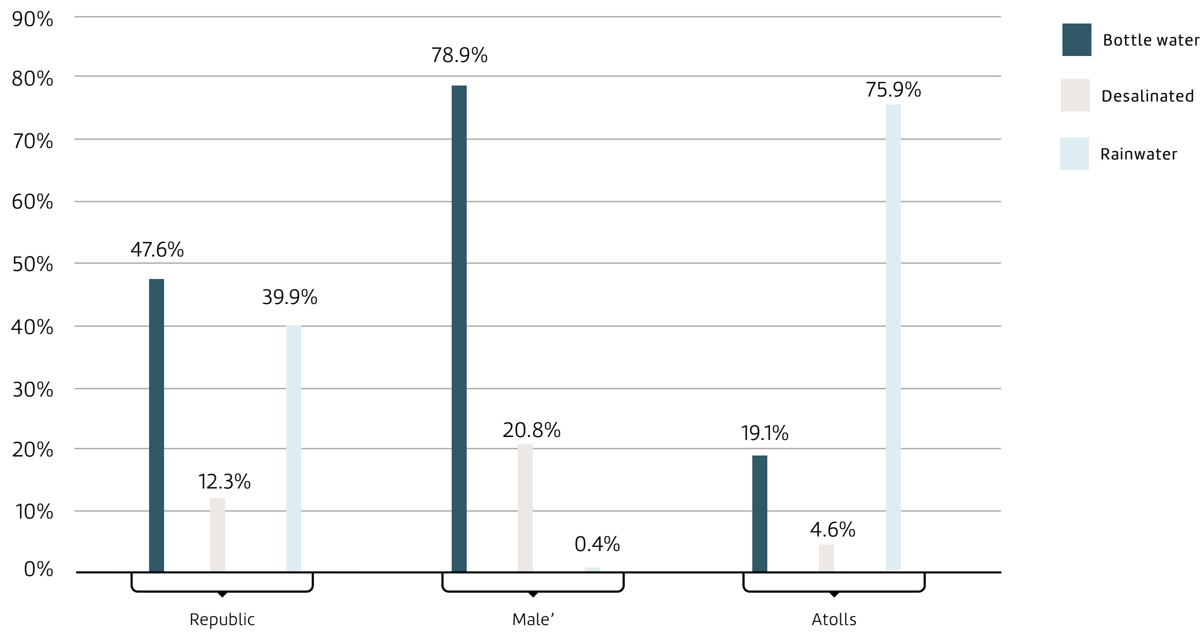
499 Maldives Bureau of Statistics. (2014). Maldives: Population and Housing Census. Statistical Release: 1 Population and Households. http://statisticsmaldives.gov.mv/nbs/wp-content/uploads/2015/10/Census-Summary-Tables1. pdf

500 Ministry of Environment and Energy. (2016). Second national communication to the United Nations framework convention on climate change. Malé. Ministry of Environment and Energy. https://unfccc. int/sites/default/files/resource/SNC%20PDF_Resubmission.pdf

501 State of Environment Maldives 2016. (2017). Ministry of Environment Climate Change and Technology. https://www.environment.gov.mv/v2/en/download/4270

Figure 67. Maldivians use rainwater, water from desalinated sources, and bottled water for drinking water purposes

Share of drinking water sources in the Maldives, Male, and atolls.



Source: HIES, 2019

Due to pollution and salinization of groundwater in many inhabited islands, many atoll islands primarily use rainwater as a potable water source.

2.5.2 Rainwater

Due to pollution and salinization of groundwater in many inhabited islands, many atoll islands primarily use rainwater as a potable water source. After the 2004 tsunami, every household in the Maldives was provided a 2500-liter high-density polyethylene rainwater collection tank.[502] Some commercial utilities also use rainwater treatment in addition to desalination operations for commercial water supply. However, rainwater harvesting is often insufficient to last the dry season, and drinking water shortages arise in the inhabited islands primarily during the months of February to April (Box 15).[503] Figure 68 presents the number of islands supplied with emergency water and the total amount supplied from 2005 to 2020. On average, approximately 3,000 tons of water were supplied annually to nearly 70 atoll islands in the years following the 2004 tsunami in the Maldives. Transportation of desalinated water occurs through shipments to islands. The cost of emergency shipments of water has exceeded Rf 2,500 per ton in recent years, and the majority of the costs of emergency water are attributed to the shipping of these supplies.[504]

502 ibid.

503 Ministry of Environment and Energy, (2017). State of the Environment Maldives 2016. In Male: Ministry of Environment and Energy, The Republic of Maldives, Malé. https://www.environment.gov.mv/v2/en/download/4270

504 National Bureau of Statistics. (2021). Statistical Yearbook. http://statisticsmaldives.gov.mv/yearbook/2021/.

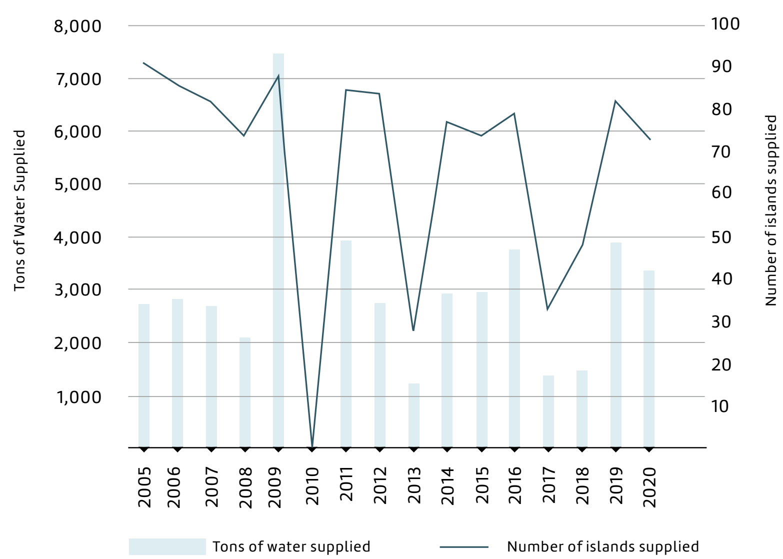
Insufficient rainwater collection may be further exacerbated by reductions in rainfall resulting from climate change.

Box 15. Rainfall patterns in the Maldives

The climate of the Maldives consists of two monsoon periods. The driest months in the Maldives are during the northeastern monsoon months of January to April, and the rainiest months of the year occur during the southwest monsoon from May to November. Average temperatures stay relatively constant throughout the year, with an average high of around 31 degrees Centigrade and an average low of 26 degrees Centigrade.[471] Average annual rainfall from 1992 to 2012 was approximately 2,000 mm per year in Male and the central atolls, 2,200 mm per year in the northern atolls, and 1,800 mm per year in the southern atolls.[472]

Figure 68. Community islands regularly need emergency water during the dry season

Islands supplied with emergency water and quantity supplied, 2005–2020



Source: Data from the Statistical Yearbook of Maldives, National Bureau of Statistics, 2021[506]

Insufficient rainwater collection may be further exacerbated by reductions in rainfall resulting from climate change. A time-series analysis of rainfall patterns from 1970s to 2011 show a slight decrease in the average annual rainfall and a significant reduction of rainy days (days with more than 1 mm of rainfall) in the

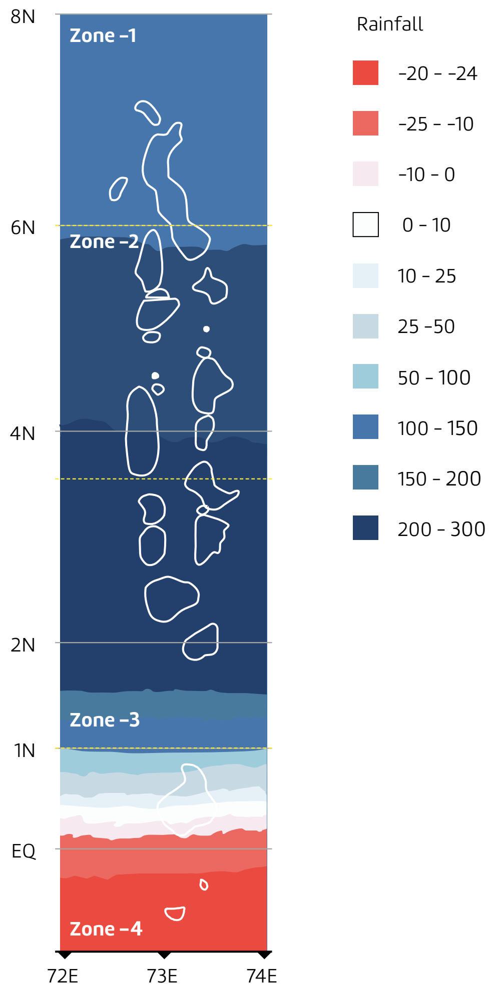
505 National Bureau of Statistics. (2021). Statistical Yearbook. http://statisticsmaldives.gov.mv/yearbook/2021/.

Projections show a decrease in rainfall in the southern atolls and an increase in rainfall in the central and northern atolls until 2050.

central and southern atolls and a late onset of the southwestern monsoon.[506] Furthermore, available climate projections suggest significant changes to rainfall patterns in the Indian Ocean in the coming century. Figure 69 shows predicted changes in precipitation resulting from global climate change for the wet monsoon months of May to October. Projections show a decrease in rainfall in the southern atolls and an increase in rainfall in the central and northern atolls until 2050.[507]

Figure 69. Rainfall is projected to decrease in the southern atolls, and to increase in the central and northern atolls from 2021 to 2050

Percent change in rainfall from May to October for the period 2021–2050 (baseline period: 1980–2000).



Source: Adopted from MEE, 2016. Predictions are from the IPRC RegCM model.

506 Ministry of Environment and Energy. (2016). Second national communication to the United Nations framework convention on climate change. Malé. Ministry of Environment and Energy. https://unfccc. int/sites/default/files/resource/SNC%20PDF_Resubmission.pdf

507 ibid.

Climate change is expected to increase rainfall variability and extreme storms and droughts. Droughts pose a significant challenge for atoll islands, especially those heavily dependent on rainwater harvesting for potable water

Climate change is expected to increase rainfall variability and extreme storms and droughts.[508] Droughts pose a significant challenge for atoll islands, especially those heavily dependent on rainwater harvesting for potable water. In cases where rainwater proves insufficient during the dry season, emergency water is supplied. Although average precipitation is expected to increase across the country, the likely scenario involves more intense storms characterized by strong winds and flash flooding.[509] The heightened severity of storms can adversely affect groundwater in two ways: first, by increasing the intrusion of saltwater into the freshwater lens, and second, by escalating surface water runoff, thereby limiting groundwater recharge and potentially contributing to groundwater and ocean water pollution. Additionally, due to climate change, the Maldives anticipates a rise in the severity of tropical storms, leading to extreme floods and increased stormwater runoff. Consequently, stormwater management has become a growing concern, particularly in urban areas. The natural sandy landscape facilitates the easy permeability of rainwater into the freshwater lens. However, increased urbanization, notably in Malé, has resulted in a higher concentration of impervious surfaces like pavement, reducing rainwater recharge. In urban areas, approximately 55 percent of rainwater results in runoff, compared to just 10 percent in natural areas.[510] As a consequence, Malé frequently experiences floods of nearly a foot during the rainy season, exacerbated by the absence of an island-wide stormwater drainage system.[511] Most stormwater in Malé is collected through catch pits and discharged into the sea, but these catch pits are often filled with solid waste and debris from roads. This stormwater carries various chemical and liquid wastes from transportation and may serve as a primary source of microplastics in water.[512]

Most stormwater in Malé is collected through catch pits and discharged into the sea, but these catch pits are often filled with solid waste and debris from roads.

2.5.3 Desalinated water

The primary source of piped-water supply in the Maldives is desalinated water. Nationwide, 70 percent of water use is estimated to be sourced from seawater.[513] Desalination plants primarily source water from boreholes of at least 30 meters in depth, which is below the freshwater lens layer. This depth is mandated by the Environmental Protection Agency of the Maldives to limit

508 UNDP. (2013). Climate Risk Management in Maldives. United Nations Development Programme (UNDP), Bureau for Crisis Prevention and Recovery (BCPR), New York.

509 Ministry of Environment and Energy. (2016). Second national communication to the United Nations framework convention on climate change. Malé. Ministry of Environment and Energy. https://unfccc. int/sites/default/files/resource/SNC%20PDF_Resubmission.pdf

510 Saraswat, Chitresh, Pankaj Kumar, and Binaya Kumar Mishra. (2016). "Assessment of stormwater runoff management practices and governance under climate change and urbanization: An analysis of Bangkok, Hanoi and Tokyo." Environmental Science & Policy 64, 101-117.

511 Ministry of Environment, Climate Change, and Technology. (2021). A guide to groundwater improvement measures in small low-lying islands of the Maldives. Malé. Ministry of Environment, Climate Change, and Technology. https://www.environment.gov.mv/v2/en/download/17353

512 ibid.

513 Moosa, L. (2021). Maldives National Water Accounts 2018 & 2019. United Nations Economic and Social Commission for Asia and the National Bureau of Statistics, Maldives. https://www.unescap.org/sites/default/d8files/2021-04/Maldives_National_Water_Account_Report_2018-2019. pdf

Outer islands, which are not equipped with desalination plants, have resorted to rainwater harvesting and importing bottled water from the mainland for drinking, while reserving groundwater for washing. All tourist resorts, however, have their own desalination plant for water supply.

over extraction of vulnerable groundwater resources. Households with private wells, however, are permitted to extract water from the freshwater lens. Desalination is conducted by reverse osmosis before being either chemically or UV light treated. Outer islands, which are not equipped with desalination plants, have resorted to rainwater harvesting and importing bottled water from the mainland for drinking, while reserving groundwater for washing.[514] All tourist resorts, however, have their own desalination plant for water supply.[515]

Water used as an intake source for desalination plants must have a salt concentration of 30 to 35 percent and an electrical conductivity between 35,000 and 60,000 μS/cm.[516] Brine outfall discharge must fall within the same range and be of similar salinity levels to ocean water. Desalination plants must report to the Utility Regulatory Authority the location and depth of the intake borehole as well as the location of the outfall discharge pipe.[517] In 2019, it is estimated that over 411 million tons of brine from desalination plants was returned to the sea. Of this total, 87.5 percent was from utility water supply, 12.4 percent was from tourism resorts, and less than 0.1 percent was from bottling plants.[518]

A key challenge regarding the supply of desalinated water to households in the Maldives is that many households prefer the taste of bottled water above utility water.

A key challenge regarding the supply of desalinated water to households in the Maldives is that many households prefer the taste of bottled water above utility water.[519] Furthermore, a survey of residents in Malé found that only 29.5 percent of respondents had trust in the piped-water supply as a source of potable water.[520] In 2014, 68 percent of households in Malé used bottled water as their primary source of potable water.[521] The dispersed island geography of the Maldives furthermore presents significant challenges in developing economies of scale, and the limited number of desalination plants per island generates additional vulnerabilities for citizens. The vulnerability of the piped-water supply was evident when a fire in a desalination plant in 2014 left approximately 100,000 citizens of Malé without water for several days, and emergency international assistance of water shipments were required.[522]

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514 Acciarri, M.F. et al. (2021). Water Resource Management and Sustainability: A Case Study in Faafu Atoll in the Republic of Maldives. Sustainability 13.6, 3484.

515 Moosa, L. (2021). Maldives National Water Accounts 2018 & 2019. United Nations Economic and Social Commission for Asia and the National Bureau of Statistics, Maldives. https://www.unescap.org/sites/default/d8files/2021-04/Maldives_National_Water_Account_Report_2018-2019. pdf

516 Utility Regulatory Authority. (2022). Desalination Plant Registration Application, 2022.

517 ibid.

518 Moosa, L. (2021). Maldives National Water Accounts 2018 & 2019. United Nations Economic and Social Commission for Asia and the National Bureau of Statistics, Maldives. https://www.unescap.org/sites/default/d8files/2021-04/Maldives_National_Water_Account_Report_2018-2019. pdf

519 Latheef, A. A. (2019, December 1). Understanding bottled water consumption: a survey on public perception of drinking water. http://saruna. mnu. edu.mv/jspui/handle/123456789/6248

520 ibid.

521 Maldives Bureau of Statistics. (2014). Maldives: Population and Housing Census. Statistical Release: 1 Population and Households. http://statisticsmaldives.gov.mv/nbs/wp-content/uploads/2015/10/Census-Summary-Tables1. pdf

522 BBC News. (2014, December 5). Maldives in water crisis after fire at treatment plant. BBC News. https://www.bbc.com/news/world-asia-30344155

In 2022, the Republic of Maldives imported nearly 2.2 million liters of bottled water.

2.5.4 Bottled water

Photo Description: Bottled water washed up on beach © Ishan

Additional efforts to reduce reliance on bottled water through increased domestic rainwater harvesting and seawater desalination have the potential to contribute to these single-use plastic reduction efforts as well as limit the environmental impacts of shipments of water from Europe.

Locally produced bottled water typically makes use of double-desalination methods to accommodate the taste preferences of households. Domestic production of bottled mineral water primarily by the Malé Water and Sewerage Company and the State Electric Company has increased, however, much of the bottled water used in the Maldives is imported. In 2022, the Republic of Maldives imported nearly 2.2 million liters of bottled water.[523] The top five countries that bottled water was imported from in 2022 were Italy, France, United Arab Emirates, Sri Lanka, and Fiji.[524] Significant improvements have been made in this area as importation of mineral water has decreased steadily from 19.1 million liters imported in 2016 and 5.6 million liters in 2018.[525] Domestic production of bottled water has increased, and nearly 95 percent of bottled water consumed is produced domestically.[526] Additional efforts to reduce reliance on bottled water through increased domestic rainwater harvesting and seawater desalination have the potential to contribute to these single-use plastic reduction efforts as well as limit the environmental impacts of shipments of water from Europe.

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523 Maldives Customs Service. (2022). Total Imports 2022. Malé: Maldives Customs Service. https://www.customs.gov.mv/Statistics

524 ibid.

525 Latheef, A. (2019). Understanding bottled water consumption: a survey on public perception of drinking water in Male', Maldives. ResearchGate. https://www.researchgate. net/publication/341521625_Understanding_bottled_water_consumption_a_survey_on_public_perception_of_drinking_water_in_Male'_Maldives

526 Moosa, L. (2021). Maldives National Water Accounts 2018 & 2019. United Nations Economic and Social Commission for Asia and the National Bureau of Statistics, Maldives. https://www.unescap.org/sites/default/d8files/2021-04/Maldives_National_Water_Account_Report_2018-2019. pdf

A significant constraint to adequate freshwater management is the lack of data gathering and monitoring of water resources, and groundwater in particular.

Bottled water consumption and plastic disposal is a significant problem in the Maldives. The GoM has taken additional steps to reduce single use plastic in recent years. In 2022, the GoM banned all imported and locally produced water packaged in plastic bottles of less than one liter in size.[527] In order to address customer demand for water of similar filtration and mineralization as bottled water, the government of the Maldives had planned to install household filtration systems in the Greater Malé Area by December 2022.[528] However, only 73 percent of surveyed households in Malé responded that they would consume utility water even after additional filtration and purification.[529] Additional efforts to promote piped-water consumption and increase trust in water utility providers are therefore needed to reduce consumption of bottled water.

2.5.5 Recommendations

Short-term recommendations

Improve data gathering and technical capacity for freshwater management. A significant constraint to adequate freshwater management is the lack of data gathering and monitoring of water resources, and groundwater in particular. The significant heterogeneity in groundwater availability and quality between atoll islands necessitates an assessment of groundwater in order to monitor groundwater use and quality over time and develop a baseline for future monitoring and management. This will involve assessing the current state of groundwater resources with water tests as well as identifying the key risks and vulnerabilities from natural and human activities.

A second key area of data gathering includes the assessment of stormwater integration into water systems. To limit the potential damage to infrastructure, livelihoods, and health and safety from increased stormwater and runoff, appropriate stormwater runoff management strategies should include (1) reducing surface water runoff, and (2) addressing stormwater quality before it is infiltrated into the groundwater.[530] An important area of study is to determine how stormwater can be effectively captured, treated, and utilized to supplement water supply, reduce dependence on and the impact on freshwater sources, and mitigate the impact of flooding. A final area of assessment is to conduct a financial and technical analysis of the current operational and maintenance practices of water supply utilities. Identifying inefficiencies in infrastructure and areas where alternative approaches could be implemented can generate cost-saving opportunities. A performance audit mechanism of the water

527 MoECCT. (2023). Single Use Plastic Phase Out Plan. https://www.environment.gov.mv/v2/en/download/11572

528 MoECCT. (2023). Single Use Plastic Phase Out Plan. https://www.environment.gov.mv/v2/en/download/11572

529 Latheef, A. (2019). Understanding bottled water consumption: a survey on public perception of drinking water in Male', Maldives. ResearchGate. https://www.researchgate. net/publication/341521625_Understanding_bottled_water_consumption_a_survey_on_public_perception_of_drinking_water_in_Male'_Maldives

530 Saraswat, C. , Kumar, P. , & Mishra, B. K. (2016). Assessment of stormwater runoff management practices and governance under climate change and urbanization: An analysis of Bangkok, Hanoi and Tokyo. Environmental Science & Policy, 64, 101–117. https://doi.org/10. 1016/j. envsci. 2016. 06. 018

and sewerage utilities can contribute to these efforts. Additional research, capacity building, and knowledge transfer is needed between government agencies, international agencies, and academic institutions. Advancing these partnerships will facilitate the exchange of technological expertise and best practices to enhance water and sewerage infrastructure in the Maldives.

Medium to long-term recommendations

Increase rainwater harvesting from available buildings wherever possible. Increased rainwater harvesting is vital to improving freshwater availability as well as minimizing runoff. Rainwater harvesting tanks can be fitted with an overflow pipe that infiltrates overflow water into the ground.[531] Rainwater that is unable to be collected must then be appropriately managed to minimize freshwater and ocean water pollution.

Increase rainwater collection, desalination, and water storage capacity and reduce reliance on bottled water. For virtually all of the country, groundwater has become unusable for drinking due to the high salinity and presence of fecal coliform. Desalinated water, bottled water, and rainwater have become the primary sources of drinking water. Increased rainwater harvesting can address both the need for increased potable water supplies as well as potentially reduce stormwater runoff.[532] Additional efforts must be made to develop a water conservation and efficiency rating mechanism to promote water conservation efforts at the household level, minimize technical losses of water, and enable the monitoring and benchmarking of water efficiency practices.

Explore the possibility of groundwater restoration. Infiltration of untreated wastewater into the ground has contributed to groundwater deterioration in the Maldives.[533] Infiltration-based drainage methods, as opposed to systems that divert stormwater to the sea, may contribute to groundwater recharge. However, for infiltration-based drainage methods to be effective, collection of pollutants in stormwater must be minimized and additional treatment of stormwater prior to infiltration may be required, preferably through natural means. Several options for sustainable drainage systems can promote groundwater recharge as well as naturally filter this stormwater including filter strips and drains, bioretention systems, swales, and infiltration and retention basins. These methods allow stormwater to pass through natural filters into the ground instead of being directed off land.

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531 Ministry of Environment, Climate Change, and Technology. (2021). A guide to groundwater improvement measures in small low-lying islands of the Maldives. Malé. Ministry of Environment, Climate Change, and Technology. https://www.environment.gov.mv/v2/en/download/17353

532 ibid.

533 ibid.

534 ibid.

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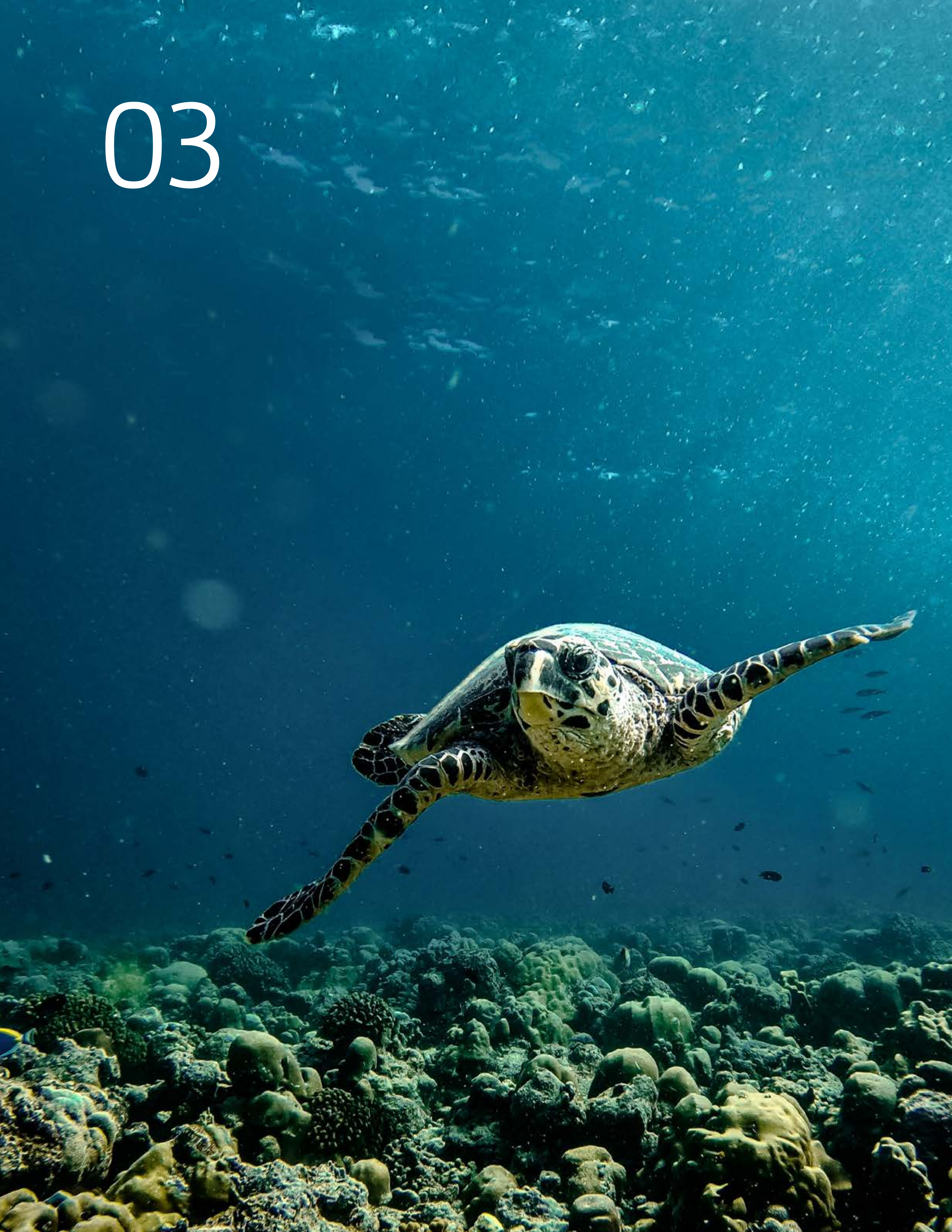


Conservation and the Sustainable Management of Marine Resources

3.1 Protected areas management

3.1.1 Overview of past and current protected areas management

National-level interest in environmental protection and conservation began in the Maldives in the early '80s, following the global prominence of the issue in the late '70s. Some of the local issues of concern at the time were coral and sand mining for housing, cutting of trees for boat building, and to some extent, littering. The Maldives began development of the sector and in 1984 the National Commission for Protection of the Environment was established with the mandate to advise the government on environmental protection and to ensure integration of environmental protection in development projects.[535] A formalized government body for environmental protection was established in 1986 and the Environmental Protection and Preservation Act (4/93) came into effect in 1993. This act has paved the way for environmental conservation and the establishment of protected areas (PAs) in the Maldives.

Along with developing the environmental sector nationally, the Maldives has continued to commit to global environmental protection efforts. The Maldives ratified the United Nations Framework Convention on Climate Change (UNFCCC) and Convention of Biological Diversity (CBD) in 1992. Maldives is a party to various international treaties and commissions relating to the seas and biodiversity conservation (Table 12).

535 MEE. (2007). Dhivehi Rajjeyge Thimaavesheege Tharaqee 1978–2007 [Development of the Environment Sector in the Maldives 1978–2007]. Male', Maldives: Ministry of Environment, Energy and Water

Table 12. International Treaties which Maldives is a party to

Treaty	Signatory (s), Ratification (r), Accession (a)
Convention on Biological Diversity	9th November 1992 (r)
Cartagena Protocol on Biosafety to the Convention on Biological Diversity	11th September 2003 (a)
United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	3rd September 2002 (a)
UN Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	12 December 2012 (s) 12 March 2013 (r)
United Nations Convention on the Law of the Sea	10th December 1982 (s) 7th September 2000 (r)
Convention on the International Maritime Organization (IMO)	31st May 1967 (s)
International Convention for the safety of Life at Sea	14th April 1981 (a)
International Convention for the Prevention of Pollution of Ships (MARPOL)	20th May 2005 (s)
International Convention for the Control and Management of Ships Ballast water and Sediments	8th September 2017 (r)
International Convention on Civil Liability for Oil Pollution Damage	14th June 1981 (a)
International Plant Protection Convention	3rd October 2006 (became a party)
Indian Ocean Tuna Commission (IOTC)	13th July 2011 (became a member)

Source: Convention websites.

Over the years, the establishment of Protected Areas has been the main method used for environmental protection in the Maldives. The first 15 PAs were established in 1995,[536] and this number has increased to the current 91 PAs comprising a total area of 62,899 ha (see Figure 70).[537,538] This is 0.06 percent of the Exclusive Economic Zone (EEZ), 1.03 percent of archipelagic waters, and 14 percent of coral reef cover of the Maldives.[539] The World Database on Protected Areas (WDPA) reports 700 hectares (=2.3%) of terrestrial PA and 62,330 hectares (0.07%) of marine PA coverage, which deviates from the total

536 The listing of PAs shared by the MoECCT has 15 initial PA while the listing shared on the EPA website has 14 PAs. A discussion on this discrepancy is given in the next section.

537 The world database on PAs (www.protectedplanet.net) list 72 PAs in the Maldives. This listing includes Baa Atoll as one PA and also has the individual PAs of Baa Atoll separately. The most recently declared areas in Kaafu and Laamu atolls are not updated.

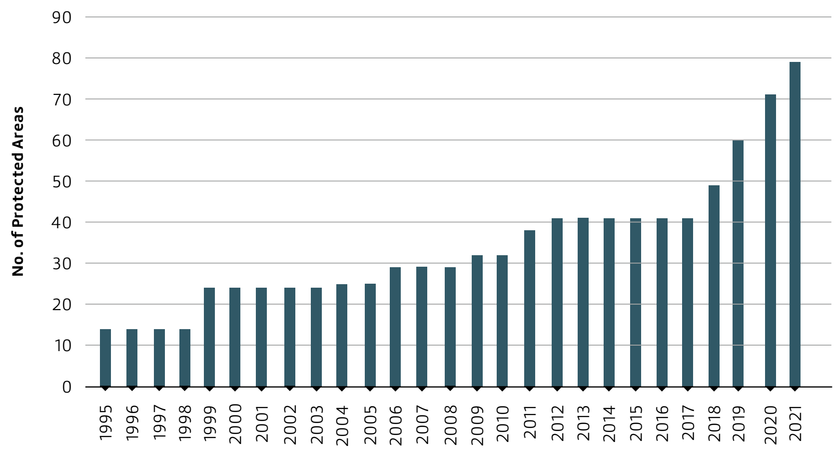
538 This figure is reported in the listing of PAs shared in the MOECCT website while a compilation of areas from the "Protected Areas of Maldives (EPA – V2.0)" KMZ file available on EPA website: https://en.epa.gov.mv/publications, gives an area of 55,653 ha.

539 Personal communication with the Ministry of Environment, Climate Change and Technology (2022, Nov 30).

PA coverage reported by the EPA (54,315 ha). Figure 70 shows a timeline of PA establishment in the Maldives since 1995. A distribution of PA numbers and area by atoll is given in Figure 71. Initial PAs were mainly dive sites, meaning they are concentrated in the tourism areas. This includes Kaafu, Baa, Alif Alif, Alif Dhaalu. Areas in the north, especially the northernmost four islands known as Boduthiladhunmathi and Laamu Atoll have been declared as protected after 2018. It should be noted that Thaa Atoll currently does not have any PAs. The largest PAs are in Vaavu Atoll and Alif Dhaalu Atoll, which are both MPAs. The number of protected areas has gradually increased since 1995.

Figure 70. The number of protected areas has steadily increased since 1995

Total number of Protected Areas in the Maldives between 1995–2021.



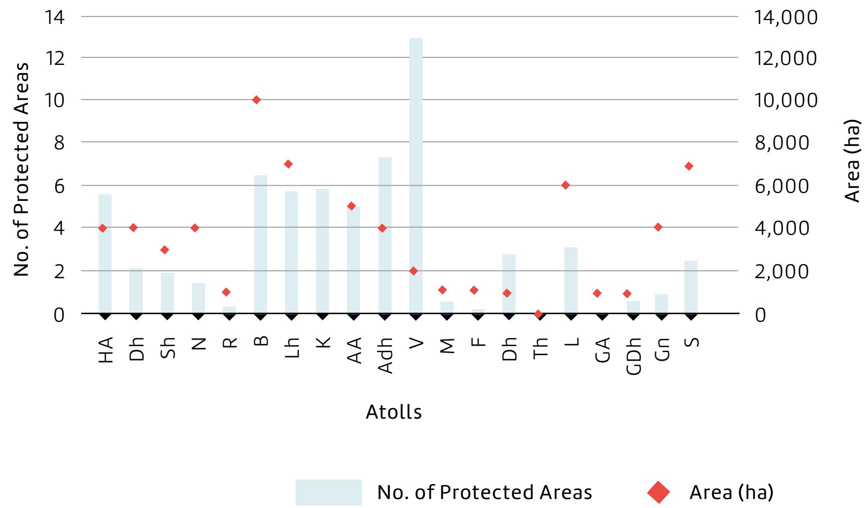
Source: WDPA.

There are different management types of MPAs, and the Maldives has still to declare some of them. Under the Protected Areas Regulation of 2018, 7 categories of PAs are defined. These generally follow the seven Protected Area categories as defined by the International Union for Conservation of Nature (IUCN) with the exception that IUCN Category V (protected landscape/ seascape) is not included. Instead, a category for internationally recognized areas is included. PAs declared after the regulation are assigned one of the 7 categories. As of 2023, 44 of the 91 PAs are assigned one of these seven categories. The majority of the 38 PAs are classified as PAs with sustainable use of resources (IUCN VI). Only 3 PAs (HA. Gallandhoo, N. Bodulhaimendhoo and Lh. Dhashugiri Finolhu) are classified as Category II (strict nature reserves), and 10 PAs are classified as Category IV (national park). Both Categories IV and VI are among the least strict categories of protection. The 41 uncategorized listings are declared before the PA Regulation and mainly include dive sites and wetland areas.

Besides regular protected areas, the Maldives also works with other designations that recognize conservation benefits, including UNESCO Biosphere Reserves, environmentally sensitive areas, and Other Effective Areas-based Conservation areas.

Figure 71. Environmental protection varies between atolls in terms of number and extent of protected areas

Number of protected areas (left scale) and total protected area (right scale) in the Maldives, by atoll



Source: World Bank

According to the current PA types reported in the EPA listing, 60 percent are MPAs. Looking across the PA establishment timeline, it can be seen that more focus is given to MPAs during the early stages. Prior to 2012, out of 38 PAs, there are only three mangrove areas. More widespread protection of mangrove and wetland areas began in 2018.

Besides regular protected areas, the Maldives also works with other designations that recognize conservation benefits, including UNESCO Biosphere Reserves, environmentally sensitive areas, and Other Effective Areas-based Conservation areas. Biosphere Reserves are internationally recognized areas designated under the Man and Biosphere program of UNESCO. Biosphere Reserves integrate the conservation of biodiversity and cultural diversity, economic development that is socio-culturally and environmentally sustainable, and logistic support, underpinning development through research, monitoring, education and training.[540] Biosphere Reserves are zoned into core areas, buffer zones, and transition areas which have different levels of protection and human activity. Three atolls (Baa, Fuahmulah and Addu) have been declared as UNESCO Biosphere Reserves.[541] The UNESCO Biosphere Reserves cover a total area of about 154,000 ha.[542]

540 UNESCO. (2023, January 23). What are Biosphere Reserves? UNESCO. https://en. unesco.org/biosphere/about

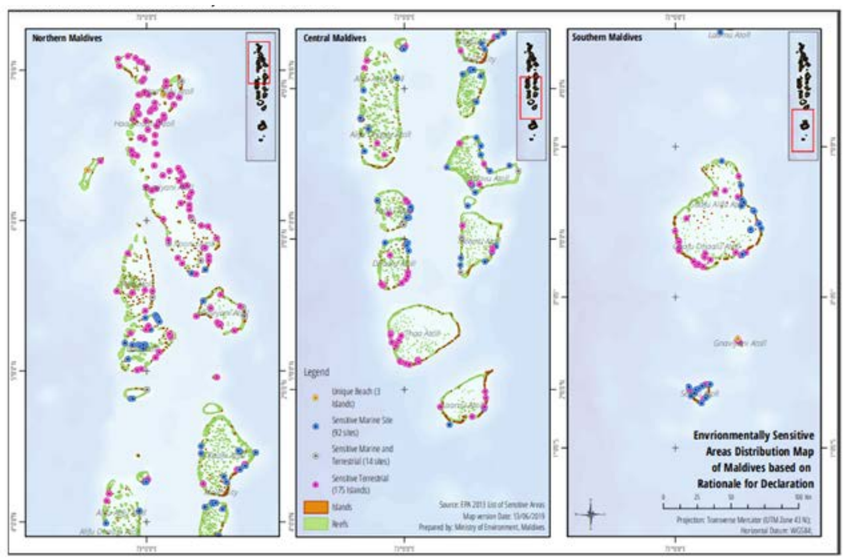
541 Despite the status as a Biosphere Reserve, the Government has recently approved a controversial large-scale reclamation project in Addu Atoll, which was identified as causing irreplaceable damage by the EIA process. Sinking Maldives plans to reclaim land from the ocean | Maldives | The Guardian

542 UNESCO. (2022, November 15). Biosphere reserves in Asia and the Pacific. UNESCO. https://en. unesco.org/biosphere/aspac

The EPA identified 250 environmentally sensitive areas across the country where no or minimal development practices are allowed.

Figure 72. Restrictions on development activities have not been strictly enforced in the Maldives

Example of land reclamation in an environmentally sensitive area (in Muli island. Project locations are marked with a red cross)



Source: CBD. https://chm.cbd.int/database/record?documentID=247054

The EPA identified 250 environmentally sensitive areas across the country where no or minimal development practices are allowed (see Figure 72).[543] These areas are maintained as a list by the EPA and do not have any legal protection status. However, development activities will consider the impact on these areas during the EIA process. There are no restrictions on sustainable use, such as snorkeling, diving, or fishing in these areas, however. The GoM has, in September 2022, launched a program to recognize areas with Other Effective Area-based Conservation Measures (OECMs) as a particular type of protected areas. OECM recognition is awarded to an area following a screening process, an ecological survey, and the preparation of a management plan. Three resorts, Hurawalhi Island Resort, Kuredu Island Resort and Spa, and Six Senses Laamu, have been chosen as candidates for OECMs in September 2023. House reefs around resort islands are protected against extractive uses and managed by resorts with the aim of ensuring that tourists have access to a good nearby reef. The Ministry of Tourism aims to increase the number of house reefs that are managed as OECMs until 2027.[544] In addition, several NGOs are in the process of establishing Community Conserved Areas (CCAs) which encourage community initiative and ownership of conservation initiatives. Given the

543 37 sensitive areas are located within PAs as of 2023. This figure is reported in the listing of PAs shared in the MOECCT website while a compilation of areas from the "Protected Areas of Maldives (EPA – V2.0)" KMZ file available on EPA website: https://en.epa.gov.mv/publications, gives an area of 55,653 ha.

544 Ministry of Tourism. (2023, May 24). Fifth Tourism Masterplan. https://tourism.gov.mv/en/downloads/master_plan

The Government is also looking into initiating a Key Biodiversity Areas (KBA) program. The KBA program is a global initiative set up to identify key sites that are significant to the health of the planet and support nationally-led efforts to identify these critical areas and support their protection.

geographical nature of the Maldives' islands, it would be challenging for the Government to implement many scattered effective conservation practices. Hence, conservation initiatives by communities are an important complement to existing Government efforts.

Table 13. Progress of NBSAP targets for PA

Type	NBSAP protection target for 2025 (Consistent with 30x30)	Reported protection
Coral reefs	10%	12 percent (as of 2022)
Mangroves and other wetlands	20%	Unknown
Sandbank	1 in each atoll	6 atolls (30%)
Uninhabited island[549]	1 in each atoll	14 atolls (74%)
Total	30%	Unknown

The GoM is also looking into initiating a Key Biodiversity Areas (KBA) program. The KBA program is a global initiative set up to identify key sites that are significant to the health of the planet and support nationally-led efforts to identify these critical areas and support their protection.[545]

...the Maldives has pledged to protect 10 percent of coral reef area, 20 percent of wetland and mangroves, and at least 1 sandbank and 1 uninhabited island from each atoll by 2025 in its National Biodiversity Strategy and Action Plan (NBSAP) 2016-2025.

The GoM has committed itself to protect 30 percent of its oceans by 2030, but data is inadequate to measure progress toward these targets. The Maldives support the CBD Convention and its Aichi targets, and has pledged to protect 10 percent of coral reef area, 20 percent of wetland and mangroves, and at least 1 sandbank and 1 uninhabited island from each atoll by 2025 in its National Biodiversity Strategy and Action Plan (NBSAP) 2016-2025.[546] Similarly, the Strategic Action Plan (SAP) 2019-2023 also had targets to protect some portion of each atoll, including at least 1 island, 1 reef, and 1 wetland by 2023.[547] As of 2022, this SAP target has been achieved in 14 atolls (70%). Data limitations make it difficult to measure progress toward the NBSAP targets regarding coral reef and wetland/mangrove areas (see Table 13). For example, the fifth national report to the UN Convention on Biological Diversity reports that 75 islands have mangroves, wetlands, or both, without distinguishing between the two ecosystems.[548] Estimates of the total area of mangroves and other wetlands vary between data sources (see Section 2.1.2). Accurate habitat maps need to be created in order to be able to measure progress toward the NBSAP targets. Another example is that of Community Conserved Areas (CCAs) that are currently being developed in Noonu Atoll, two of which are not reported in the CBD report.[549]

545 KeyBiodiversityAreas.org. (n.d.). Key Biodiversity Areas. https://www.keybiodiversityareas.org/

546 Ministry of Environment and Energy. (2015). National Biodiversity Strategy and Action Plan 2016-2025. Male

547 Government of Maldives. (2019). Strategic Action Plan 2019-2023. Male' https://presidency.gov.mv/SAP/

548 Ministry of Environment and Energy. (2015). Maldives Fifth National Report to the United Nations Convention on Biological Diversity. Ministry of Environment and Energy. https://www.cbd. int/doc/world/mv/mv-nr-05-en. pdf

549 Gnaviyani atoll consists of 1 inhabited island, Fuvahmulah. Hence this atoll is not considered in the calculations.

Limited financial resources and technical and institutional capacity is the main challenge to establishing and managing Protected Areas.

3.1.2 Barriers to effective Protected Areas Management

Protected areas currently have limited conservation impact in the Maldives. This is because they only cover about 5 percent of Maldives's territorial waters and 1 percent of archipelagic waters.[550]

Limited financial resources and technical and institutional capacity is the main challenge to establishing and managing PAs. Limited national funding is available for environmental conservation and protection efforts, which hampers effective PA management. Potential sources for generating PA funding include i) own revenue generation at the PA, ii) donor funding, and iii) domestic revenue allocation. Currently, revenues are generated from admission fees and tourism-based activities in only three PAs: Hanifaru, Addu Nature Park, and Fuvahmulah Nature Park.[551] Not all PAs may have the same potential for generating revenues. Implementation of most conservation activities in the Maldives are initiated through international donor-funded projects, which gets turned over to the Government for continuation. The establishment of Baa Atoll as a Biosphere Reserve, and the Addu and Fuahmulah Nature Parks are examples of such donor-driven conservation initiatives. Domestic revenue allocation to PA management is limited in the Maldives, with proceeds from the Green Fund hardly being allocated to PA management (see Section 5.4).

Under the Decentralization Act, local councils are now mandated with governing natural resources within their jurisdiction and the Government is geared towards assigning management roles of PAs to local councils.

Not only does the central government have limited technical staff for PA management, but local councils also lack the technical capacity to govern natural capital within their jurisdiction. Under the Decentralization Act, local councils are now mandated with governing natural resources within their jurisdiction and the Government is geared towards assigning management roles of PAs to local councils. Local councils have reported the need to develop technical capacity within the councils to be able to take up this large mandate. The Guraidhoo Island Council (Kaafu Atoll) has taken up an initiative with a local NGO (Small Island Geographic Society) to help build the capacity of the Council to formulate management plans for marine areas. This is the first initiative of its kind, and it is expected that other Councils will follow. There is a national need to develop training materials to help Councils facilitate the development and implementation of management plans. Such training should include various aspects of PA management including management planning, sustainable financing, conducting resource and resource use assessments, monitoring, and research among others.

Due to a lack of Government resources and technical capacity, the majority of legal PAs are "paper parks" without any established management plans and without any organized management action taken. Therefore, there is no monitoring of human activities in these areas and of conservation outcomes. Only 5 PAs have management plans developed and implemented (Hanifaru,

550 Personal communication with the Ministry of Environment, Climate Change and Technology (2022, Nov 30).

551 These parks are described in detail in Section 3.2

Large-scale land reclamation projects have been carried out near MPAs causing damage from sedimentation.

Olhugiri and Mendhoo in Baa Atoll, and the Addu and Fuvahmulah Nature Parks), with the development of eight management plans underway as of 2023 (for 2 PAs in Baa Atoll and 6 PAs in Laamu atoll).

The PA Regulation (2018/R-78) that came into effect in 2018 reinforces decentralized protected area management, but funding is a key issue. Under this regulation, all PAs and sensitive areas have to be declared and published in the gazette by the MoCCEE. The EPA is responsible for implementing this regulation and has the discretion to delegate its authority to relevant State authorities. The Regulation prescribes that a management plan should be prepared for PAs either by the EPA or another party as the delegated management authority. While it may be significant that the Decentralization Act (07/2010) gives legal recognition to atoll and island councils to govern the use of natural resources within their jurisdiction, PAs management has remained under EPA's jurisdiction. However, under the discretion given to the EPA in the PA Regulation, the EPA can delegate management authority to an external state authority. This discretion is utilized in the transfer of management authority to Addu and Fuvahmulah City Councils in the management of the PAs in the regions.[552] Island Councils nearest to some PAs have been given some authority for compliance monitoring of PA rules violations. These are generally monitoring access to the PAs and if any illegal activities are carried out. Consultations with Councils have reported that these assigned authorities do not come with financial resources and Councils are not given the right to impose user or access fees to generate revenue for monitoring.

There are many examples where the PA status of an area has been ignored, and development activities have continued. Tourism activities have been permitted in the uninhabited island of Mendhoo in the Baa Atoll Mendhoo Region PA with some regulations as per the Mendhoo management plan.[553] Large-scale land reclamation projects have been carried out near MPAs causing damage from sedimentation. The development in Gulhi Falhu is an example of where development happened near the popular dive site Hans Hass Place MPA. The recent reclamation in Addu Atoll, which is a UNESCO Biosphere Reserve, has been reported to spur economic losses of US$ 4.8 to 7.7 million and US$ 17 to 27.4 million per year for dive operators and the tourism industry, respectively.[554] The report also identified that several MPAs (Maa Kandu Manta Point, Kuda Kandu, and British Loyalty Wreck) will be affected by sedimentation due to the close proximity to sand-borrowing areas. Similar to PAs, despite the identification of areas as ecologically sensitive areas by the EPA, often these areas get ignored during development activities. One such example is the ecologically sensitive area in the island of Muli which has been reclaimed for land expansion (see Figure 73 below).

552 Hanifaru PA is managed by the Baa Atoll Biosphere Reserve Office located in Eydhafushi and is under the MoECCT.

553 Ministry of Tourism. (n.d.). New Developments. Ministry of Tourism. https://www.tourism.gov.mv/en/registered/new_developments

554 Areeba. (2022, February 14). Environment Impact Assessment for Addu land reclamation project submitted to EPA. The Times of Addu. https://timesofaddu.com/2022/02/14/environment-impact-assessment-for-addu-land-reclamation-project-submitted-to-epa/

38 percent of Maldivian resorts organize dive excursions to marine PAs (e.g., Hanifaru Bay) for their guests, charging a fee of between US$75 and US$150 per person per trip.

Figure 73. Restrictions on development activities have not been strictly enforced in the Maldives

Example of land reclamation in an environmentally sensitive area (in Muli island. Project locations are marked with a red cross)

Source: CBD. https://chm.cbd.int/database/record?documentID=247054

Marine PAs are an increasingly important component of the tourist experience offered by Maldivian resorts. 38 percent of Maldivian resorts organize dive excursions to marine PAs (e.g., Hanifaru Bay) for their guests, charging a fee of between US$75 and US$150 per person per trip.[555] The demand for PA excursions is increasing, with more than half of the resorts reporting an increase in demand between 2023 and 2018.[556] Since increasing PA visitation can adversely affect the health of marine ecosystems, it is paramount that this particular use of PAs is regulated and monitored.

There is a lack of baseline information and multi-temporal monitoring to assess the performance of PAs in terms of ecosystem health. This is despite the monitoring of changes to the state of PAs being required under the PA Regulation (2018/R-78). Baseline information is important for benchmarking PAs and continuously improving management. The Government is planning to incorporate the IUCN

555 *World Bank & Ministry of Tourism led Environment and Climate Survey of Resort Islands (2023).*

556 ibid.

There is limited awareness of the use restrictions in protected areas. The need for improved information and awareness of PAs has been identified in several studies done on PA management in the Maldives.

Green List (GL) Standard for the evaluation of performance and effectiveness of PAs. The MoCCEE is working with IUCN, GoM, on the GL standard and has submitted a project proposal for Global Environment Facility (GEF) funding, which includes capacity building and training to introduce the IUCN GL Standard. The use of the GL Standard offers an opportunity for PA management effectiveness to be assessed against a series of management actions.

There is limited awareness of the use restrictions in protected areas. The need for improved information and awareness of PAs has been identified in several studies done on PA management in the Maldives.[557] This includes information on the existence of PAs as well as the prescriptions of activities that are allowed and not allowed in PAs. While such information is shared during declarations and is available in formal announcements, continued information sharing and reminding has been identified as important. Proper management plans, if implemented, would have a PA management office/authority in the region and staff working to inform people, monitor activities, enforce management rules, monitor the health of PAs and share information on these with the public. Thus, local communities and the general public will continuously be engaged with the PA and will provide continued visibility of the PA. Conservation knowledge repositories and dissemination platforms need to be developed at the national level and maintained beyond the project timeframe.

None of the managed PAs in the Maldives measure visitor impacts and official long-term monitoring and research programs have not yet been established in any PA in the Maldives.

PA visitation is unregulated and unmonitored. Unregulated tourism activity at PAs is a primary threat to conservation of these sites. Importantly, none of the managed PAs in the Maldives measure visitor impacts and official long-term monitoring and research programs have not yet been established in any PA in the Maldives. The relatively high incidence of injured whales in the unregulated South Atoll Marine Protected Area (SAMPA) (compared to Hanifaru Bay) Shows that measuring and regulating PA visitation is crucial for the health of marine wildlife.

3.2 Towards more sustainable Nature-Based Tourism

3.2.1 The sustainability of tourism in the Maldives

The Maldives aims to position itself as an ecotourism destination.[558] The tourism policies formulated in the Strategic Action Plan 2019-2023 (SAP) emphasize the importance of ecotourism. Tourism policies are, among other things, aimed at working with the environmental sector to facilitate the preparation of management plans and developing regulations that promote eco-tourism in protected areas.

557 Mohamed, M. (2008). Economic valuation of coral reefs: a case study of the costs and benefits of improved management of Dhigali Haa, a marine protected area in Baa atoll, Maldives. https://ir. canterbury. ac. nz/handle/10092/1473

558 Ministry of Tourism. (n.d.). Maldives tourism master plan 1996-2005. https://www.tourism.gov.mv/en/downloads/master_plan

It is of critical importance to intergrate tourism carrying capacity assessments into planning frameworks, such as strategic environmental analysis.

Box 16. Tourism Carrying Capacity

Tourism carrying capacity refers to the maximum number of visitors that a tourist destination can handle without compromising their environmental integrity or the quality of the visitor experience, or negatively impacting the local community and culture. It's typically assessed when touristic activity reaches a tipping point, where the some of these key aspects intersect:

- Physical carrying capacity – The facilities and infrastructure in a destination become fully utilized and can no longer accommodate additional visitors effectively.

- Environmental carrying capacity – when the natural environment of a tourist destination starts to suffer from negative impacts, such as pollution or habitat degradation, due to the demands of tourism.

- Perceptual or psychological carrying capacity – the point at which the overall visitor experience begins to deteriorate, often due to overcrowding or excessive development

- Socio-cultural carrying capacity – where tourism adversely affects local culture, heritage, and the quality of interactions between residents and tourists.

Given Maldivian tourism sector's substantial reliance on its Blue Natural Capital, along with its direct impact on this resource, underscores the critical importance of integrating tourism carrying capacity assessments into planning frameworks, such as strategic environmental analysis. By tracking tourism volume with its environmental footprint, the government can use tourism carrying capacity assessments to regulate tourist numbers – either through pricing strategies or by setting sustainability caps. This would ensure that the island's resources are not overstretched. Consequently, there's a prompted shift towards diversification of the country's tourism portfolio away from luxury resorts, promoting relatively more eco-friendly options like guest houses, community-based tourism, and the exploration of untapped cultural, culinary, and mangrove-related touristic experiences.

Promotion of nature-based tourism, benefits local communities through the promotion of local foods, culture, heritage and sustainable marine practices are among those highlighted.

The Fifth Tourism Master Plan 2023-2027 (5TMP) was launched by the Government in May 2023.[559] Among the goals and strategies outlined, there is emphasis on the natural environment, especially the marine ecosystems of the Maldives. Promotion of nature-based tourism, benefits local communities through the promotion of local foods, culture, heritage and sustainable marine practices are among those highlighted. Goal 4 on building climate resilience and protection of natural assets, especially identifies the importance of management of MPAs and includes activities such as development of management plans, promotion of OECMs and stewardship initiatives, implementation of responsible visitor programmes, monitoring of reef health through citizen science as well as small community grant schemes for coral reef conservation.

Box 17. Nature-based and eco-tourism definitions

Nature-based tourism refers to any form of leisure travel that involves enjoyment of nature or natural resources in wild or unspoiled form. This can include visiting wildlife, natural landscapes or adventure-based nature interactions. The Maldives is a prime example of a nature-based tourist destination, as it attracts visitors from around the world who come to enjoy unique underwater beauty, beaches, and diving and snorkeling opportunities.

Definitions of **eco-tourism** encompass more depth in relation to nature and sustainability while incorporating well-being of local communities and education. The International Ecotourism Society (TIES) defines ecotourism as "responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education" (ecotourism.org).

There are 883 registered guest houses with a total bed capacity of 14,506 in the Maldives.

BoAs of February 2023, there are 883 registered guest houses with a total bed capacity of 14,506 in the Maldives.[560] The majority of these guesthouses are located near the Greater Malé Region and the central region of the country. Guesthouses provide an opportunity for local communities to diversify their incomes. In outer islands, guesthouses are typically small establishments with 6 to 8 bedrooms. Large city hotel type guesthouses often have more than 20 bedrooms. Development of guesthouses in local communities have seen positive environmental conservation benefits where residents are making efforts to keep beaches clean and also conserve mangrove areas as attractions.

559 Ministry of Tourism. (2023). Maldives Fifth Tourism Master Plan 2023-2027: Goals and Strategies. https://www.tourism.gov.mv/dms/document/4969b4831928f1bdf3506340fb6974fc. pdf

560 Ministry of Tourism. (2023). Tourism Statistics. https://tourism.gov.mv/en/downloads/reports

Tourism in the Maldives remains concentrated primarily around resort islands in close proximity to nature but without the eco-tourism elements of local community benefits and education.

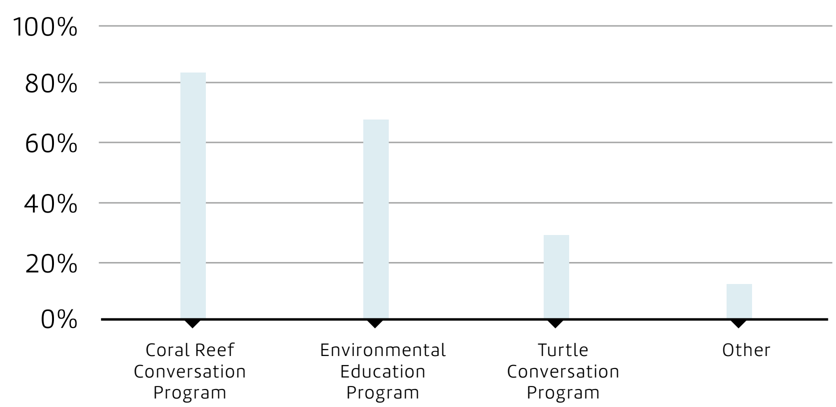
With increased autonomy of local councils under the Decentralization Act, more guidelines on guesthouse development need to be in place to avoid overflow of tourism infrastructure and impact the use of local natural resources.

Recent policies on guesthouse operations have the potential to increase benefits to local communities. In particular, the 2010 Maldives Guesthouse Regulation made it possible to operate guesthouses in inhabited islands, and the 4th amendment to this regulation (Dec 2021) additionally allows for homestay tourism in residential units.[561] Furthermore, Maldives Fund Management Corporation (MFMC), a 100 percent State-Owned Enterprise, prepared a proposal for eco-lodging near and within mangroves in Addu and Fuvahmulah (as of 2022).

Tourism in the Maldives remains concentrated primarily around resort islands in close proximity to nature but without the eco-tourism elements of local community benefits and education. Many resorts have coral reef conservation programs (84 percent) or environmental education programs (68 percent) (see Figure 74). A smaller fraction of resorts has a turtle conservation program (28 percent). However, these programs exist with the aim of offering the possibility to visit corals under conservation or restoration. This means that there is potential to develop eco-tourism further by adopting the conservation of the environment as a principal aim of eco-tourism.[562]

Figure 74. Most resort islands engage in conservation or education activities.

Share of resorts engaging in conservation and education activities. Note: The Other category includes Manta Ray Research and Waste Management Center tours.



Source: World Bank & Ministry of Tourism led Environment and Climate Survey of Resort Islands (2023).

561 Shareef, H. (2022, October 2). Fourth Amendment to the Regulation on the Operation of Guesthouses – CTL Strategies. CTL Strategies. https://www.ctlstrategies.com/latest/4th-amendment-to-regulation-on-operation-of-guesthouses/

562 Cater, C. & Cater, E. (2007). Marine Ecotourism: Between the Devil and the Deep Blue Sea. Centre for Agriculture and Bioscience International, Oxfordshire. http://sherekashmir. informaticspublishing.com/696/1/9781845932596. pdf

With most resorts reporting that tourists are increasingly interested in MPA excursions, there is an urgent need to monitor and manage the potential environmental impacts of this trend.

Box 18. PA Management at Hanifaru Bay, Baa Atoll

Hanifaru Bay in Baa Atoll was declared a PA in 2009 by the Government of the Maldives. It is one of the core areas of the UNESCO Biosphere Reserve in Baa Atoll. The bay is globally recognized for the seasonal aggregations of manta rays and whale sharks and is a popular tourist destination. There are a number of restrictions in place to manage impacts of tourist activities at the site.

These include:

- Prohibition of scuba diving and fishing
- A limit of number of visitors per day of 80 visitors
- A limit on maximum 5 vessels to be using the area at one time
- All visitors must be guided by a certified Hanifaru guide.
- No person entering the waters is allowed to disturb whale sharks or mantas.

An on-site office is set up with rangers to monitor for compliance. All visitors to the bay have to pay a fee of US$20, which goes to the Baa Atoll Conservation Fund (BACF; www.broffice.gov.mv). Other sources of funding for the BACF include Government contributions, grants, exam registration fees, and partnership fees from the private sector. A core amount of the BACF is set aside to manage the operations of the reserve.

With most resorts reporting that tourists are increasingly interested in MPA excursions,[563] there is an urgent need to monitor and manage the potential environmental impacts of this trend. This is because MPA visitation has been reported to negatively affect marine wildlife. For example, studies have raised concerns over increases in pressure and threats from unrestricted tourism growth' at Hanifaru Bay.[564] The Manta Trust, in their studies conducted in 2010, observed increases of 82 percent in boats and 158 percent visitors per day compared to 2009 following the declaration as a protected area. A 2021 comparison study shows that the regulated Hanifaru Bay offers a better tourist experience than the South Ari Marine Protected Area (SAMPA), largely due to the fact that there are less wildlife injuries and less crowding in the Hanifaru Bay. Whale shark watching at SAMPA and Hanifaru are major revenue generators for these areas. A recent study done in SAMPA showed that 61 percent of surveyed whale sharks had at least one major injury from a boat while nearly all had minor scrapes and grazes.[565] Hanifaru, where visitor activity is regulated, also reported some injuries to manta rays and whale sharks from boats. The management office believes these injuries are from boats as these megafauna travel to Hanifaru Bay. Therefore, the management has identified a need to set speed limits for boats in the migration channels. While there are independent groups doing marine research in Hanifaru and other PAs, it

563 ibid.

564 Brooks, K. (2010). Investigating tourism at Hanifaru Bay marine protected area, Maldives. Master Thesis, University of York Environment Department. https://www.cms. int/sharks/sites/default/files/publication/%27Investigating%20Tourism%20at%20Hanifaru%20Bay%20marine%20protected%20area%2C%20Maldives%27%20Katie%20Brooks%20%282010%29. pdf

565 Ocean Country Partnership Programme (2022). Report of Protected Area Management Effectiveness Evaluations for three sites in the Maldives.

Eco-tourism needs to be developed in tandem with protected area management.

is unclear if the findings are incorporated into improving management of PAs. The monitoring of user numbers and activities is important for understanding visitor impacts and developing strategies to reduce these impacts.

Eco-tourism needs to be developed in tandem with protected area management. The Maldives' MPAs are important to the country's tourism sector as they offer highly valued nature-based opportunities.[566] Conversely, some activities in the tourism sector, such as the protection of dive sites, simultaneously contribute to conservation goals. Tourism can also bring in revenues that can help finance PA management (See Box 18 below). Implementation of a small access fee on top of current rates for MPA visits will likely not decrease demand for these visits (e.g., an access fee of $20, which is charged for entering Hanifaru Bay, increases the price by only 13-27%).

The decentralized governance of natural resources management may pose challenges to the development of a nationally coherent eco-tourism strategy. Recent amendments to the Decentralization Act and the Strategic Action Plan 2019-2023 give more autonomy to Island Councils for managing areas within their jurisdiction and generating revenues in these areas. Lagoons, inhabited islands, sandbanks and other marine areas now often fall under the jurisdiction of Island Councils. This may lead to increased conservation action in some jurisdictions while development is emphasized in other jurisdictions. For example, the K. Guraidhoo Island Council is currently developing management plans for the marine areas in their jurisdiction in response to high visitor numbers and a decline in manta populations. This stands in contrast with the 2022 announcement of F. Nilandhoo Island Council to reclaim two islands in their jurisdiction and develop resorts on these islands.[567] The decentralized model requires additional efforts to keep track of development across the country and to align them with the national ecotourism agenda.[568]

Photo Description: Bird sitting in tree, Maldives © World Bank

566 Blanco-Cerradelo, L. , Diéguez-Castrillón, M. I. , Brea, J. a. F. , & Gueimonde-Canto, A. (2022). Protected Areas and Tourism Resources: Toward Sustainable Management. Land, 11(11), 2059. https://doi.org/10. 3390/land11112059

567 One Online. (2022, 29th November). Two resorts to be developed in Nilandhoo lagoon. https://oneonline.mv/en/70859

568 Maldives Tourism Climate Action Plan (2023) https://www.tourism.gov.mv/dms/document/1faaf2b096cca9b5b8141c0094b54d55.pdf

Box 19. Towards Sustainable Tourism Offerings in the Maldives

The recently launched "Maldives Tourism Climate Action Plan,"[568] led by the Maldivian Ministry of Tourism, emerged from a year of in-depth research and stakeholder consultations. This plan articulates five core strategic objectives: 1) weaving in community experiences and priorities, 2) preserving destination assets, 3) nurturing nature, 4) broadening business models, and 5) aligning with international initiatives. It presents a plethora of avenues to diversify the Maldives' tourism offerings. Emphasis is placed on nature-centric experiences that both highlight the Maldives' pristine beauty and aid its ecological restoration. It encourages activities where tourists can engage in seagrass restoration and offers educational tours emphasizing the vital role of coastal vegetation in erosion prevention. Mangrove tours are also proposed, highlighting their importance in coastal defense and biodiversity. It advocates for blending local community experiences and products into touristic offerings. Below we provide three such models that go beyond the traditional resort-centric tourism centering around the "Sun, Sand, and Sea" experience.

The islands of Baa Goidhoo, Fehendhoo, and Fulhadhoo in Baa Atoll have introduced tourism experiences like mangrove mud baths, fly fishing adventures, crab hunting sessions with locals, and immersive farm tours that end with sunset culinary lessons. These efforts, championed by local guesthouses in tandem with communities, not only elevate the tourist experience but also support the islands' ecological resilience and ensure a fair distribution of tourism-derived benefits.

Addu Atoll's regional resorts in partnerships with the Addu Meedhoo Cooperative Society are promoting indigenous agricultural produce and creating touristic experiences focusing on agriculture in 40 islands.

The Laamu Hithadhoo wetland, home to the Maldives' largest mangrove forest (43.3 hectares) was recognized as a Protected Area (PA) in December 2021. Recognising the untapped potential of this ecosystem, the Hithadhoo Island Council has envisioned a sustainable tourism agenda. Their tourism portfolio is centered on activities like canoeing, nature education trails, picnicking, foraging mangrove fruits and nature photography, all designed to enable visitors to deeply engage with the area's natural heritage. Instead of significantly altering land use, the council advocates for minimalistic developments that harmonize with the environment. The council's infrastructure plan within the PA is centered around community-driven amenities such as local accommodations with guest houses, homestays and cafes. The council aims to balance tourism demands with community welfare and environmental stewardship. However, the project is currently on hold until management plans are finalized, and the government formally assigns management authority to the council.

With the right encouragement, these initiatives have the potential to serve as a model for community-based tourism across the Maldives

Substantial funding for biodiversity conservation can be generated by establishing National Parks and charging entry fees...

Substantial funding for biodiversity conservation can be generated by establishing National Parks and charging entry fees as part of the national ecotourism strategy.[569,570] For example, Addu National Park, established in 2008 (see Box 20), generates enough revenues to cover the cost of managing the area.[571] It is unknown, however, to what extent this model has improved biodiversity conservation outcomes in the National Park. This is an urgent knowledge gap as more management plans are being developed.

569 Emerton, L., Baig, S. and Saleem, M. (2009). Valuing biodiversity: the economic case for biodiversity conservation in the Maldives. AEC project, Ministry of Housing Transport and Environment, Government of Maldives and UNDP Maldives; Vorhies, F. (2020). Sustainable conservation financing in the Maldives. Male': International Union for Conservation of Nature. http://www.environment.gov.mv/v2/wp-content/files/publications/20210228-pub-sust-consrv-financing-in-maldives.pdf

570 Mohamed, M. (2008). Economic valuation of coral reefs: a case study of the costs and benefits of improved management of Dhigali Haa, a marine protected area in Baa atoll, Maldives. https://ir. canterbury. ac. nz/handle/10092/1473

571 Personal communication with Aminath Afaa (Assistant Director at Addu Nature Park management office, January 2023).

In the Maldivian tourism sector, tourists are charged based on the "polluter pays" principle.

Box 20. Addu and Fuvahmulah Nature Parks

Addu and Fuvahmulah Natures Parks are PAs in Addu Atoll and the island of Fuvahmulah that have been developed in 2018 as ecotourism attractions under the Climate Change Adaptation Project (CCAP) funded by World Bank. Addu Nature Park (ANP) consists of Eydhigali Kilhi wetlands and Koattey area in Hithadhoo Island while Fuvahmulah Nature Park (FNP) includes the protected wetlands Bandaara Kilhi, and Dhandimagu Kilhi. The objectives for establishing the nature parks were to develop ecotourism and other sustainable activities that can contribute to the socio-economic development of the local community. The project has been seen a success with high community acceptance and interest across the country in enjoyment of these areas. Management of these areas were initially under the EPA but in 2021, the management has been transferred to the respective Island Councils. This is the first case of management responsibility of PAs to be transferred to local councils. The process of transfer of the management responsibility is still in a transition stage according to management officials.

Addu Nature Park

Source: visitmaldives.com

Fuvahmulah Nature Parks

Source: Time of Addu

3.2.2 The role of fiscal policy in tourism-related sectors

In the Maldivian tourism sector, tourists are charged based on the "polluter pays" principle. The taxation of tourists helps internalize some of the environmental damage caused by tourism. For example, many tourists stay in Maldivian resorts in close proximity to coral reef ecosystems. These resorts cause disturbances in the coral reef ecosystems due to dredging and sand-pumping activities and the disposal of sewage and waste.[572] To compensate, and as part of their NDC, the Maldives established a Green Tax in 2015.[573] The Green Tax charges US$ 6 per night to tourists staying in resorts, hotels, and vessels. With an average vacation duration of 9.2 days in 2021,[574] tourists are charged a total of US$ 55 per vacation, on average. The tax specifically targets foreign tourists, with Maldivians and permanent residents being exempt from paying

572 Cowburn, B. , Moritz, C. , Birrell, C. L. , Grimsditch, G. , & Abdulla, A. (2018). Can luxury and environmental sustainability co-exist? Assessing the environmental impact of resort tourism on coral reefs in the Maldives. Ocean & Coastal Management, 158, 120–127. https://doi.org/10. 1016/j. ocecoaman. 2018. 03. 025

573 MEE. (2015). Maldives' Intended Nationally Determined Contribution. https://policy.asiapacificenergy.org/sites/default/files/Maldives%20INDC%20.pdf

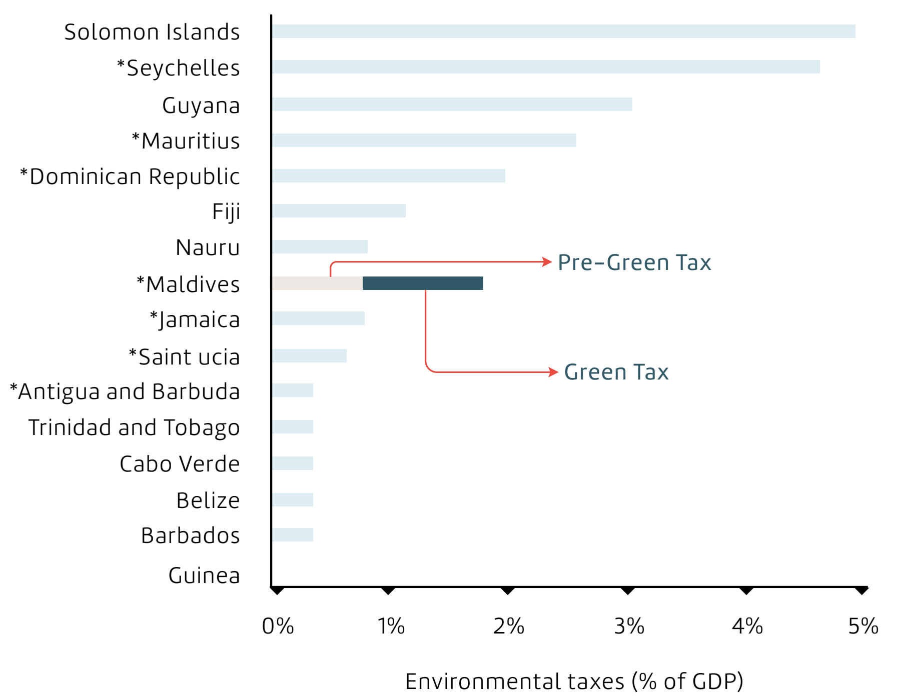
574 Maldives Bureau of Statistics. (2021). Maldives Statistics Yearbook 2021. http://statisticsmaldives.gov.mv/yearbook/2021/

In 2018, the GoM established a Green Fund to collect and manage the proceeds from the Green Tax...Between 2019 and 2022, most of the proceeds were used to finance improvements of sewage and waste infrastructure, water supply systems, and coastal protection.

the tax. In 2018, the GoM established a Green Fund to collect and manage the proceeds from the Green Tax. The proceeds are used to finance environmental projects. Between 2019 and 2022, most of the proceeds were used to finance improvements of sewage and waste infrastructure, water supply systems, and coastal protection. The Green Tax equaled about 1 percent of GDP in 2021 and is hence a meaningful addition to other tax revenues (around 19 percent of GDP since 2015).[575]

Figure 75. Environmental taxes were relatively low until the introduction of the Green Tax in 2015, when environmental taxes started exceeding those in most SIDS.

Taxes related to the environment as percentage of GDP in the Maldives and 15 other SIDS between 2010 and 2020. Countries with an asterisk belong to the upper-middle-income category.



Source: OECD and Maldives' Ministry of Finance. https://stats.oecd.org/Index.aspx?DataSetCode=ERTR

Environmental fiscal policy (EFP) can help limit or offset harmful impacts from tourism on the environment.

Environmental fiscal policy (EFP) can help limit or offset harmful impacts from tourism on the environment.[576] Examples of typical EFPs include user fees charged to tourists visiting a conservation area and taxes on plastic bags. EFP are desirable because they internalize environmental damages into market prices. EFP also helps raise funds for the provision of public goods, such as coral reef restoration and educational opportunities. The revenue-raising potential of environmental fiscal policies is particularly attractive for

575 OECD. (2020). Revenue Statistics in Asia and the Pacific: Key findings for the Maldives. https://doi.org/10. 1787/db29f89a-en

576 World Bank (2019). Fiscal Policies for Development and Climate Action. https://www.worldbank.org/en/topic/macroeconomics/publication/fiscal-policies-for-development-and-climate-action

The Green Tax generates significant funds without reducing the attractiveness of the Maldives as a high-end holiday destination.

the Maldives where tax revenues have historically lagged and where the cost of climate adaptation is expected to strain future government budgets.[577,578]A cross-country comparison suggests that environmental taxes in the Maldives are on par with other SIDS since the introduction of the Green Tax. The Green Tax, first collected in 2015 (see Table 14), doubled the hitherto relatively small amount of environmental taxes (based on OECD) from 0.8-1.8 percent of GDP (in 2019) (see Figure 75). With several other SIDS still raising substantially more environmental taxes than the Maldives, there may be potential for optimizing the country's environmental fiscal policies.

The Green Tax generates significant funds without reducing the attractiveness of the Maldives as a high-end holiday destination. The Green Tax generated Rf 706 million per year (US$ 46 million per year, exchange rate of December 2022) between 2019 and 2022, which equals 2.6 percent of government expenditure.579 Most of the Green Tax proceeds were used to improve sewage systems (47 percent) and waste management (24 percent) (see Figure 76). The Green Tax did not have a significant impact on international tourist arrivals because the demand for tourism in high-end destinations such as the Maldives is price insensitive.[580] The implication is that the Green Tax generates funds without jeopardizing tourist arrivals, but future revenues critically depend on the preservation of the elements that make the Maldives a high-end tourist destination.

Further increasing the Green Tax can help mitigate the environmental damages from tourism in two important ways. First, a higher Green Tax has the potential to reduce the number of tourist arrivals to an optimal level because higher market prices would deter some tourists from coming to the Maldives. The resulting decrease in environmental damages depends on how sensitive tourists are to an additional price increase, which is currently unknown, but for the high value tourism typical for the Maldives expected to be rather insensitive. In addition, a prerequisite for being able to determine the optimal Green Tax is knowing how much environmental damages each tourist causes in the Maldives. This is also currently unknown, so that the optimal level of the Green Tax cannot be computed. Nevertheless, a surefire benefit of increasing the Green Tax is that it generates additional revenues that can be used to mitigate environmental damages from tourism, such as waste pollution and the adverse impacts of tourism-related infrastructure (e.g., ports and dredging channels (see Chapter 3) on nearby coral reefs. Hence, an additional increase in Green Tax should be considered alongside other measures to reduce environmental impacts from the tourism sector.

577 IMF 2022. Technical Assistance Report. Country Report No. 22/187

578 Aligishiev et al. 2022. Macro-Fiscal Implications of Adaptation to Climate Change. Staff Climate Notes 2022/002.

579 Ministry of Finance. (2023). Green Fund Report. https://www.finance.gov.mv/publications/statistical-releases/green-fund-report

580 IMF 2022. Technical Assistance Report. Country Report No. 22/187

Only a limited share of the Green Fund has been used for conservation purposes. As of 2022, only two conservation projects were funded by the Green Fund.

Table 14. A timeline of the establishment of a Green Tax and Green Fund

Year	Milestone
2015	Tourists staying in resorts, hotels, and vessels are charged a green tax of $US 6 per tourist per night based on the Tourism Act
2016	Tourists staying in guesthouses are charged a green tax of US$ 3 per tourist per night based on the Tourism Act
2018	Establishment of a green fund to manage the proceeds from the green tax
2019	Annual revenues into green fund: Rf 850,615,153.85
2020	Annual revenues into green fund: Rf 351,774,688.30
2021	Annual revenues into green fund: Rf 802,132,208.55
2022	Annual revenues into green fund: Rf 820,949,474.87
2023	Tourists in all large tourist establishments and guesthouses (more than 50 rooms) must pay US$ 6 per night and US$ in smaller tourist establishments (less than 50 rooms)

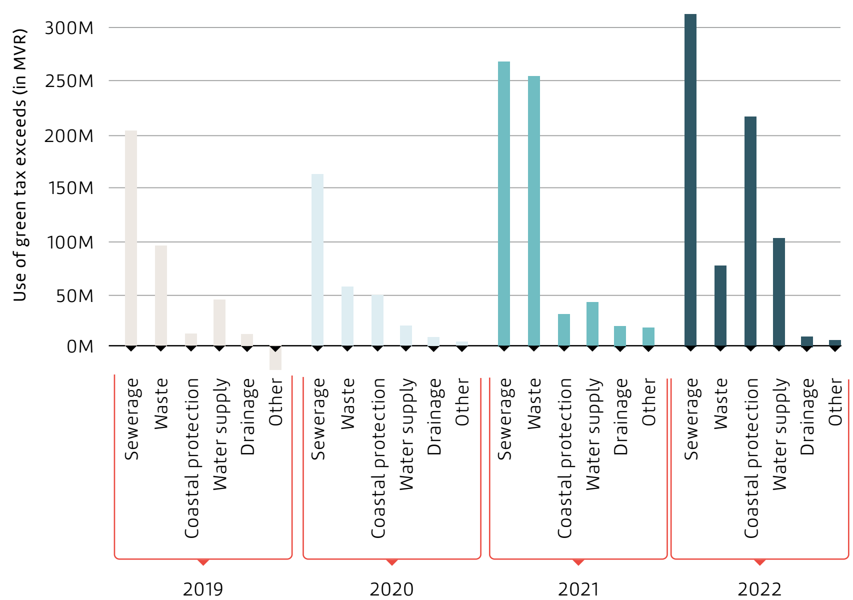
Source: Ministry of Finance 2022. Green Fund Report. https://policy.asiapacificenergy.org/sites/default/files/Maldives%20INDC%20.pdf

Only a limited share of the Green Fund has been used for conservation purposes. As of 2022, only two conservation projects were funded by the Green Fund. These projects have a combined budget of $170,503 and are aimed at preserving the Mathikilhi wetland area and the Hithadoo protected area, the latter comprising coral reef and mangrove vegetation and water bodies. Both projects are located in the Addu atoll. The limited allocation of Green Tax proceeds to ecosystem and biodiversity conservation suggests that the fund, in its current form, contributes mainly indirectly to natural capital conservation.

Photo Description: Yachts on dock,Maldives © World Bank

Figure 76. Most Green Fund proceeds are used for sewage and waste projects, while virtually none are used for conservation purposes

Allocation of Green Fund proceeds between 2019 and 2022



Source: Own calculations based on Ministry of Finance 2022. Green Fund Report

Tourism Goods and Services Tax (TGST) internalizes some of the environmental externalities generated by the tourism sector. The TGST covers goods and services provided to tourists by resorts, hotels, guesthouses, and travel agencies. In January 2023, the TGST was increased from 12 percent to 16 percent.581 The General Goods and Services Tax (GGST) was also increased from 6 percent to 8 percent, but it is worth noting that the TGST rate is much higher than that of the GGST. It is unusual for countries to apply a higher GST in the tourism sector. Small tourism-dependent countries typically employ a lower GST rate in the tourism sector to promote the development of the sector.[582] An unintended benefit of the elevated GST rate is that it internalizes some of the environmental externalities associated with tourism. The TGTST is not likely to reduce international tourist arrivals due to the inelastic demand for high-end holiday destinations. A major drawback associated with increasing the tourism related taxes is that it makes the government budget more dependent on a single economic sector. For example, the Maldives witnessed a reduction in Green Tax revenues of 59 percent when the tourism sector shrank by 64 percent due to the COVID-19 pandemic in 2020. A more diversified tax base from domestic resources such as income tax, property tax, and corporate tax, and measures to improve the current tax system to avoid leakages, will make

581 MIRA 2022. https://www.mira.gov.mv/Gst.aspx

582 IMF 2022. Technical Assistance Report. Country Report No. 22/187

the country's fiscal position more resilient to macroeconomic shocks, which ultimately also contributes to the uninterrupted funding of environmental projects.

Airport taxes are an additional source of revenues that have little impact on international tourist arrivals. The airport tax consists of airport charge and a departure tax. As of 2022, the total tax increased from US$ 50 to US$ 60 for international visitors. Domestic travelers pay US$ 24. In a general sense, airport taxes recover the cost of passengers transiting through an airport. On the other hand, the recent increase in airport taxes can be argued to internalize some of the environmental damages that tourists cause by traveling to the Maldives by air transport. These damages include contributions to local air and noise pollution as well as global warming. The airport tax differs from the Green Tax in that tourists are charged a fixed amount irrespective of the duration of their stay. The airport tax can be expected to have an equally limited impact on international arrivals because the price increment equals only 2.3 percent of the average total cost of a vacation to the Maldives (US$2,627 per international tourist[583]). In comparison, international tourists are on average charged US$ 48 under the Green Tax scheme, which equals 1.8 percent of the total cost of the vacation.[584] For domestic travelers, the airport tax of US$ 24 can be expected to have a larger impact on the travel budget as their spending on domestic travel is US$ 112 per year, on average.[585] The airport tax is an important source of funding for the government budget that can be expected to grow in line with increasing tourist arrivals.

3.3 Blue Carbon

The IPCC defines Blue Carbon (BC) as "All biologically driven carbon fluxes and storage in marine systems that are amenable to management." So far, BC has largely been understood as rooted wetland vegetation in the coastal zone, such as tidal marshes, mangroves and seagrasses, but open-ocean (macro-algae) and deep-sea (phytoplankton) ecosystems are also key BC components.[586] Countries wishing to develop Blue Carbon strategies (BCS) can define their own BC components as far as there is a clear connection with the ocean and inundation contributes to the accumulation of soil carbon. Blue carbon ecosystems must be wetlands. Blue Carbon strategies are part of NbS, which cover all cost-effective practices that manage ecosystems for adaptation and mitigation purposes (See Section 2.3.4). Coral reefs are carbon fixing structures and could be BC systems. However, they are excluded from BC

583 UNWTO. (n.d.). 145 key tourism statistics. https://www.unwto.org/tourism-statistics/key-tourism-statistics

584 This is calculated based on the assumption that the average international visitor stays in a touristic accommodation for eight nights.

585 Own calculations based on Housing and Household Characteristics: Census (2014) and Ministry of Tourism Study on Domestic Tourism In the Maldives (2016).

586 Hilmi, N. , Chami, R. , Sutherland, M. R. , Hall-Spencer, J. M. , Lebleu, L. , Benítez, M. J. , & Levin, L. A. (2021). The Role of Blue Carbon in Climate Change Mitigation and Carbon Stock Conservation. Frontiers in Climate, 3. https://doi.org/10. 3389/fclim. 2021. 710546

Coastal wetlands are very fast-growing ecosystems with Net Primary Productivities (NPP) (a proxy for growth) equal to other very productive ecosystems like rainforests.

initiatives because the calcifying process in corals releases CO2 as a byproduct. Thus, coral reefs are generally considered a small net source of CO2 rather than a net sink despite supporting photosynthetic algae, and are excluded from BC frameworks.[587]

Coastal wetlands are very fast-growing ecosystems with Net Primary Productivities (NPP) (a proxy for growth) equal to other very productive ecosystems like rainforests. As an example, mangroves' aboveground NPP can reach 11.1 tonnes of dry weight (DW) per hectare and per year with a median value of 8.1 t DW ha-1 year-1.[588] These values are very similar to tropical terrestrial forests, with mean rates of aboveground NPP being 11.9 t DW ha-1 year-1 and a median value of 11.4 t DW ha-1 year-1.589 Seagrasses are equally productive, with NPP values for Indonesia ranging between 5.62-8.40 tons of carbon per hectare and per year.[590] Coastal wetlands are, therefore, relevant carbon sinks (i.e., they absorb much more carbon than they release). Moreover, the accumulation of carbon in their soils over prolonged periods of time makes these coastal wetlands relevant carbon stocks (i.e., they hold a large quantity of carbon per area unit). In the Western Indian Ocean (WIO), soil carbon stocks in seagrass and mangrove ecosystems represent 70 percent and 30.[591]

When Blue Carbon ecosystems degrade or disappear, vast amounts of additional carbon is released into the atmosphere, contributing to global warming.

High productivity and rich soil carbon deposits make Blue Carbon ecosystems highly relevant for climate change mitigation (see Figure 77).[592] As shown by carbon-dating techniques, carbon stored in their soils has accumulated for millennia and would not be recovered in a human lifetime if they were degraded.[593] Thus, when Blue Carbon ecosystems degrade or disappear, vast amounts of additional carbon is released into the atmosphere, contributing to global warming. The conservation of these stocks on the soil through avoided deforestation and degradation, as well as restoration activities are mitigation actions of global relevance. Blue Carbon ecosystems also provide other benefits, including coastal protection, habitat and food provision, and support for fisheries, aquaculture, tourism, and timber industries.

Blue Carbon strategies are long-term initiatives to conserve, restore, and manage Blue Carbon ecosystems, frequently with the goal of mitigation action

587 Christianson, A., Cabré, A., Bernal, B., Baez, S. K., Leung, S. Y., Pérez-Porro, A. R., & Poloczanska, E. S. (2022). The Promise of Blue Carbon Climate Solutions: Where the Science Supports Ocean-Climate Policy. Frontiers in Marine Science, 9. https://doi.org/10. 3389/fmars. 2022. 851448

588 Alongi, D. M. (2012). Carbon sequestration in mangrove forests. Carbon Management, 3(3), 313-322. https://doi.org/10. 4155/cmt. 12. 20

589 ibid.

590 Wahyudi, A. J., Rahmawati, S., Irawan, A., Suherman, S., Prayudha, B., Hafizt, M., Afdal, A., Adi, N. S., Rustam, A., Hernawan, U. E., Rahayu, Y. P., Iswari, M. Y., Supriyadi, I. H., Solihudin, T., Ati, R. N. A., Kepel, T. L., Kusumaningtyas, M. A., Daulat, A., Salim, H. L., . . . Kiswara, W. (2020). Assessing Carbon Stock and Sequestration of the Tropical Seagrass Meadows in Indonesia. Ocean Science Journal, 55(1), 85-97. https://doi.org/10. 1007/s12601-020-0003-0

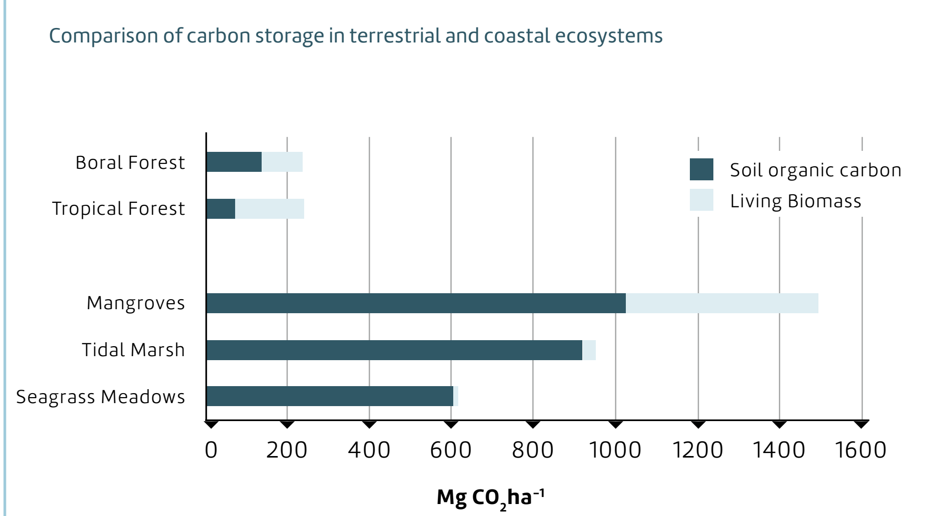
591 Blue carbon lab. (2020). Blue Carbon Research in the Tropical Western Indian Ocean. https://seyccat.org/wp-content/uploads/2020/01/BlueCarbonLab_LitReport_Seychelles_20210301_final.pdf

592 Macreadie, P. I., Costa, M. D. P., Atwood, T. B., Friess, D. A., Kelleway, J. J., Kennedy, H., Lovelock, C. E., Serrano, O., & Duarte, C. M. (2021). Blue carbon as a natural climate solution. Nature Journal, 2(12), 826-839. https://doi.org/10. 1038/s43017-021-00224-1

593 Atwood, T. B., Connolly, R. M., Almahasheer, H., Carnell, P. E., Duarte, C. M., Lewis, C. J. E., Irigoien, X., Kelleway, J. J., Lavery, P. S., Macreadie, P. I., Serrano, O., Sanders, C. J., Santos, I. R., Steven, A., & Lovelock, C. E. (2017). Global patterns in mangrove soil carbon stocks and losses. Nature Climate Change, 7(7), 523-528. https://doi.org/10. 1038/nclimate3326

and with expectations of financial benefits through the selling of carbon credits. However, neither mitigation action nor carbon credits should be the main goal of Blue Carbon Strategies, which can focus on reinforcing other benefits of these ecosystems (such as adaptation against extreme events and flooding, food security, water management, biodiversity) by properly managing the ecosystems to support these services.

Figure 77. Avoiding the deforestation or degradation of Blue Carbon Ecosystems potentially prevents the release of large amounts of already stored soil carbon



Source: Blue Carbon Initiative

3.3.1 Blue Carbon potential in the Maldives

Global interest in and momentum for Blue Carbon is increasing and the Maldives may benefit from it.

Global interest in and momentum for Blue Carbon is increasing and the Maldives may benefit from it. This is evidenced by the wide range of ongoing Blue Carbon initiatives, such as Australia's Blue Carbon platform,[594] IUCN's Great Blue Wall–[595] including a Partnership for Western Indian Ocean mangrove reforestation and the International Blue Carbon Initiative[596] (IUCN-CI-UNESCO)– and the Blue Carbon Implementation Lab.[597] These initiatives represent a useful source of knowledge and experience that can aid the development and implementation

594 Government of Australia. (2019). Wetlands Australia 31: Australian Government initiatives for blue carbon - DCCEEW. https://www.dcceew.gov.au/water/wetlands/publications/wetlands-australia/national-wetlands-update-february-2019/govt-initiatives-blue-carbon

595 IUCN. (2022). Global launch of the Great Blue Wall. https://www.iucn.org/news/secretariat/202111/global-launch-great-blue-wall

596 The Blue Carbon Initiative. (n.d.). The Blue Carbon Initiative. https://www.thebluecarboninitiative.org/#:~:text=The%20International%20Blue%20Carbon%20Initiative,the%20most%20productive%20on%20Earth.

597 UNFCCC. (2022). Outcome Document Action Event: Blue Carbon Implementation Lab. https://unfccc. int/sites/default/files/resource/MPGCA_COP27_IL_Blue_Carbon_OD_3011. pdf

Although funding can be attracted through climate change mitigation in BC ecosystems, the financial returns are often overestimated and there are significant costs related to the process of structuring Blue Carbon credits.

of a Blue Carbon Strategy in the Maldives.

Although funding can be attracted through climate change mitigation in BC ecosystems, the financial returns are often overestimated and there are significant costs related to the process of structuring Blue Carbon credits.[598] Expectations about financial returns are not met because financial returns are not determined by stored carbon stocks, but rather by the additional carbon that projects are able to avoid releasing or sequestering through activities that deviate from a Business as Usual (BAU) baseline. Moreover, the fixed costs associated with monitoring, reporting, validating, and verifying these additional stocks are higher than in other ecosystems because Blue Carbon Ecosystems are difficult to monitor, measure, and restore due to their coastal location (e.g., mangroves can be located on water-land transitions) and conditions (e.g., seagrasses may need full underwater monitoring, and data analysis strongly relies on laboratory work).[599]

Despite global expectations about the financial benefits that blue carbon mitigation projects can provide, very few projects are currently operating in the carbon market.

Despite global expectations about the financial benefits that blue carbon mitigation projects can provide, very few projects are currently operating in the carbon market.[600] The list of barriers is diverse and complex, with a critical one being the high fixed cost per project.[601] Currently, the selling of credits rarely covers investment costs. Costs for blue carbon projects remain higher than in other projects due to accessibility difficulties, higher monitoring costs (MRV), more specialized personnel to run measurements, a more complex set of greenhouse gasses (methane and nitrous oxide are also relevant), and need for capacity building.[602] Third party independent validation-verification processes would be among the fix-costs (e.g., approx. $100,000 USD fixed costs per validation & verification independently of project size),[603] and the selling price of the credits remains low (i.e., the price is project-specific and varies depending on pre-establish agreements with buyers, but it ranges between 8 USD to a maximum of 30 USD per ton of $CO2$ per hectare per year). Blue carbon credit sales attract a premium in comparison to traditional large-scale REDD+ projects, partly because of their strong focus on community benefits and co-benefits (e.g., adaptation), but this is generally not sufficient to operate for-profit models.[604]

598 Friess, D. A. , Howard, J. , Huxham, M. , Macreadie, P. I. , & Ross, F. (2022). Capitalizing on the global financial interest in blue carbon. PLOS Climate, 1(8), e0000061. https://doi.org/10. 1371/journal. pclm. 0000061

599 Wahyudi et al. (2020). https://link.springer.com/article/10.1007/s12601-020-0003-0

600 Friess, D. A. , Howard, J. , Huxham, M. , Macreadie, P. I. , & Ross, F. (2022). Capitalizing on the global financial interest in blue carbon. PLOS, 1(8), e0000061. https://doi.org/10. 1371/journal. pclm. 0000061

601 ibid.

602 Teutli-Hernández C., J.A. Herrera-Silveira, D.J. Cisneros-de la Cruz., R. Román-Cuesta. (2020). Mangrove ecological restoration guide: Lessons learned. Mainstreaming Wetlands into the Climate Agenda: A multilevel approach (SWAMP). CIFOR/CINVESTAV-IPN/UNAM-Sisal/PMC, 4

603 The Nature Conservancy, personal communication.

604 Friess, D. A. , Howard, J. , Huxham, M. , Macreadie, P. I. , & Ross, F. (2022). Capitalizing on the global financial interest in blue carbon. PLOS, 1(8), e0000061. https://doi.org/10. 1371/journal. pclm. 0000061

605 ibid.

Box 21. The Cispata Bay Blue Carbon Project in Colombia

In the Cispata Bay Blue Carbon Project in Colombia, local communities and authorities, researchers, and NGOs work together to restore and preserve 11,000 hectares of mangroves. This is expected to lead to the sequestration of about 1 million tons of CO2 over 30 years. The project is also expected to generate several co-benefits, including biodiversity conservation and community benefits. The project is supported by upfront financing, and the blue carbon credits that are generated are verified, registered, and later sold in the Voluntary Carbon Market. Carbon credits for the Cispata Blue Carbon project were first issued by Verra in 2021. Proceeds are managed by a board consisting of local stakeholders, local representatives and technical advisors. In this project, the carbon credits cover 70 percent of the project cost. The remainder is funded by the government and international sources.[605]

The Maldives could create a national carbon trading system for Blue Carbon by developing a simplified national standard, or continue using international standards and methodologies but apply national validation/ verification bodies.

The lack of economies of scale is a key barrier to the feasibility of developing Blue Carbon projects in the Maldives. Partly due to the high fixed costs of producing blue carbon credits for the international carbon market, investors in Blue Carbon projects prefer large areas (e.g., 5,000 hectares) and minimum mitigation targets of 100,000 tons of CO2e per year (e.g., suggested by conditions for BC investments in Yucatan by a large corporation willing to invest in mangrove restoration and conservation).[606] In a place like the Maldives, these values would be too ambitious for mangroves but project proponents could still target action on smaller jurisdictions under Voluntary Carbon Markets (e.g., Atoll level, island level or resort level) other than the national scale.

In the Maldives, mangrove projects could still compensate public or private emissions, including island-level resorts or municipalities, by developing its own methodologies and a national registry. To reduce the cost of BC validation, verification and complicated methodologies and monitoring systems, some countries are developing simplified national and local carbon standards that still guarantee additionality but offer less expensive approaches for carbon certification at the domestic level (e.g., Australia has its national carbon standard for fire management,[607] Mexico has a national carbon standard for forestry projects to compensate its compliance carbon market[608]). The Maldives could create a national carbon trading system for Blue Carbon by developing a simplified national standard, or continue using international standards and methodologies but apply national validation/verification bodies (VVB). Whatever standard is developed cannot compromise key variables for carbon trading, including: i) reliable emission baselines (historical GHG emissions/ removals by mangroves or other BC components in the area of the project, ii) mitigation additionality, iii) permanence, and iv) leakage, which are fundamental conditions for selling carbon credits that are trustable and do not lead to

606 CINVESTAV, personal communication.

607 Carbon Market Institute. (2022, September 13). West Arnhem Land Fire Abatement (WALFA) Project Carbon Market Institute. https://carbonmarketinstitute.org/projects/west-arnhem-land-fire-abatement-walfa-project/

608 Chambers and Partners. (n.d.). Climate Change Regulation 2022 - Mexico | Global Practice Guides https://practiceguides. chambers.com/practice-guides/climate-change-regulation-2022/mexico/trends-and-developments

Because of their larger extent, seagrasses are a more attractive option for national scale blue carbon investment in the Maldives.

greenwashing (e.g. overestimating the additional emissions/removals that the project provides, leading to more credits than the project really produces, allowing companies to pollute (with GHG) more than they really compensate with the carbon credits). This national approach would still require increased investment as BC projects are expensive and financial returns still remain a problem. But it would offer a more manageable approach for domestic carbon trading, and if the standards and MRV systems were transparently and robustly defined, it could engage international buyers. A well-defined governance and legal setting would also be needed to implement and monitor the integrity of these transactions. A registry and a third-party national verification system will still be needed.

Because of their larger extent, seagrasses are a more attractive option for national (and smaller jurisdictional) scale blue carbon investment in the Maldives. Methodologies exist under the Voluntary Carbon Market for seagrass restoration (e.g., VM033, VERRA)[609]. No methodology exists yet for seagrass avoided degradation. Ongoing projects that are successfully selling BC credits for seagrass restoration are limited to two as in May 2023: there is one under VERRA VM0033 and another under Plan Vivo in Kenya (covering 300 hectares).[610]

Commercial BC projects with algae (e.g., kelp and seaweed farming) are also starting to emerge in the tropics thanks to the development of methodologies for algae usage. For example, the commercial use of seaweed for cosmetics is an opportunity that the Maldives may also want to explore. In the Indian Ocean, Zanzibar has achieved successful benefits from seaweed farming for cosmetics and the tourism industry.[611]

For seagrass and mangrove restoration projects, the Maldives can use methodology VM0033 under VERRA.[612] To initiate an assessment on seagrass mitigation potential through restoration, the Maldives needs to focus on two key variables:

1. *Changes in area of seagrasses.* In the Maldives, the University of Northumbria has developed maps of shallow seagrass meadows for 2021 and is working on multitemporal assessments.

2. *Changes in carbon stocks (fluxes) in seagrasses.* Under the VM0033 methodology, seagrass biomass needs to be measured, but the most relevant carbon stock is soil carbon and soil accretion rates. Only seagrass

609 Verra. (2022, November 9). VM0033 Methodology for Tidal Wetland and Seagrass Restoration, v2. 0 - Verra. https://verra.org/methodologies/vm0033-methodology-for-tidal-wetland-and-seagrass-restoration-v2-0/

610 Friess, D. A. , Howard, J. , Huxham, M. , Macreadie, P. I. , & Ross, F. (2022). Capitalizing on the global financial interest in blue carbon. PCLM, 1(8), e0000061. https://doi.org/10. 1371/journal. pclm. 0000061

611 Seaweed Center (2019). 100% Natural Cosmetics from Sea algae Straight from Zanzibar. Strong glow. https://seaweed. pl/en/

612 Verra. (n.d.). https://verra.org/methodologies/vm0033-methodology-for-tidal-wetland-and-seagrass-restoration-v2-0/

The Maldives must leverage its Blue Carbon ecosystems for coastal adaptation. While mitigation has been the target of many BC Strategies, equally or more valuable is to focus on their provision of coastal protection.

projects located in areas where tides and ocean currents permit soil sedimentation will lead to additional soil carbon and credits. Therefore, the location of potential seagrass carbon projects is of great relevance to guarantee that a minimum threshold of soil sedimentation is reached. Currently established projects not fulfilling a threshold of 5 percent accretion rates per year are not considered additional.[613] There is, however, little data and knowledge of soil carbon storage, soil sedimentation rates, and biomass productivity in Maldivian seagrasses and mangroves. Some work has been done by the University of Northumbria under a 2.5-year Leverhulme Trust-funded project that aims to quantify seagrass blue carbon storage and accretion rates at Huvadhoo Atoll. The Blue Carbon Lab and Six Senses Laamu have recently collected soil cores from 3 seagrass sites and 3 mangrove sites in the Laamu Atoll (2020) and data should be available soon.

Blue Carbon ecosystems are estimated to reduce costs associated with impacts such as flooding by over USD $65 billion annually.[614] The Maldives must leverage its Blue Carbon ecosystems for coastal adaptation. While mitigation has been the target of many BC Strategies, equally or more valuable is to focus on their provision of coastal protection. Many island nations have developed BC Strategy with a goal of protecting BC ecosystems for their multiple provision of services: Cuba's "Manglar[615,616] aims to increase the climate resilience of over 1.3 million vulnerable through ecosystem-based adaptation, the Seychelles raised US$15 million frominternational investors to finance the sustainable use of fisheries and marine resources[617] or the South Australian BC Strategy, which aims at accelerating action to protect and restore coastal ecosystems to reduce GHG emissions.[618]

The Maldives, at present, does not have a Blue Carbon Strategy. The Maldives can benefit from knowledge sharing from other on-going BC Strategies in the Indian Ocean to prepare its own robust BC strategy. The starting points for any plausible BC Strategy include adequate governance, data collection and analysis, and responsive management.[619] The following steps need to be taken:

1. Development of baselines of current GHG emissions and removals by selected BC components (e.g., mangroves, seagrasses, algae);

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613 ibid.

614 World Economic Forum. (2022). Harnessing Coastal Blue Carbon Ecosystems for Climate Change Mitigation and Adaptation. World Economic Forum. https://www3.weforum.org/docs/WEF_HC_Blue_Carbon_2022.pdf

615 Reliefweb. (2021). From Manglar Vivo to Mi Costa - Cuba. ReliefWeb. https://reliefweb. int/report/cuba/manglar-vivo-mi-costa

616 Green Climate Fund. (2021). FP157: Coastal Resilience to Climate Change in Cuba through Ecosystem. https://www.greenclimate.fund/project/fp157

617 World Bank. (2018, October 31). Seychelles launches World's First Sovereign Blue Bond. https://www.worldbank.org/en/news/press-release/2018/10/29/seychelles-launches-worlds-first-sovereign-blue-bond

618 Government of Australia. (2022, November 28). Blue Carbon. https://www.environment. sa.gov. au/topics/climate-change/government-action-on-climate-change/climate-change-blue-carbon-strategy

619 World Bank. (n.d.). Unlocking Blue Carbon Development. Investment Readiness Framework for Governments. Unpublished report

The Maldives, at present, does not have a Blue Carbon Strategy. The Maldives can benefit from knowledge sharing from other on-going BC Strategies in the Indian Ocean to prepare its own robust BC strategy.

2. Cost-benefit analyses of emission reductions or removals through new projects;

3. Revision of national MRV frameworks, competences and governance settings.[620]

Ground data collection and satellite imagery will be need to be developed and implemented through a robust MRV system that provides traceable, transparent, high quality and frequent data to follow up GHG emissions and removals by the proposed new measures and activities. A robust governance setting is a precondition for developing a Blue Carbon Strategy (see, e.g., Seychelles' Blue Carbon Roadmap),[621] as well as for its implementation (e.g., Australia's initiatives on Blue Carbon).[622]

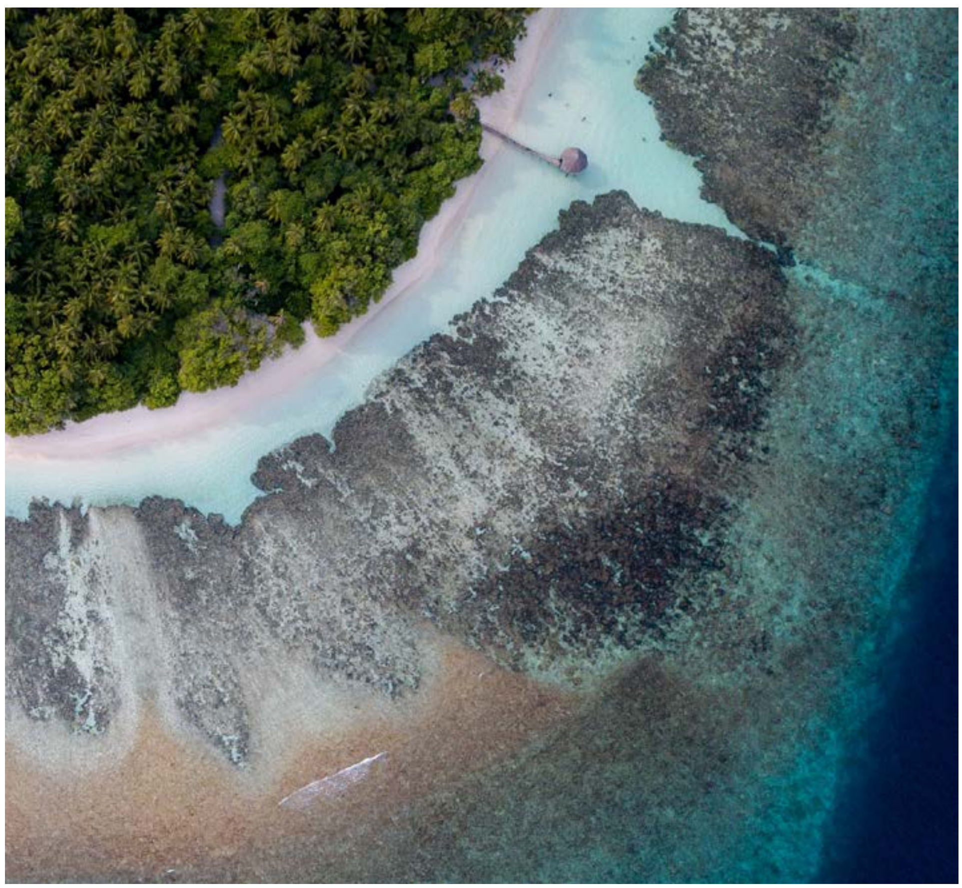

Photo Description: Ariel view of beach in Kihaadhoo, Maldives by © Ibrahim Mohamed /Unsplash

620 UNFCCC. (n.d.). Nationally Determined Contributions. Costa Rica First NDC (Updated submission). https://unfccc. int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs

621 Palacios, M. M. , Costa, M. D. P. , Wartman, M. , Ebrahim, A. , & Macreadie, P. I. (2022). Seychelles' Blue Carbon Roadmap. Submitted to the Seychelles Conservation & Climate Adaptation Trust. Blue Carbon Lab, Deakin University, Australia. https://www.bluecarbonlab. org/wp-content/uploads/2022/09/SeychellesBlueCarbonRoadmap_Report_202209. pdf

622 Government of Australia. (2019). Wetlands Australia 31: Australian Government initiatives for blue carbon - DCCEEW. https://www. dcceew.gov.au/water/wetlands/publications/wetlands-australia/national-wetlands-update-february-2019/govt-initiatives-blue-carbon

Table 15. Summary of plausible Blue Carbon strategies in the Maldives

		Commercial					Non-commercial		
		Nationally Determined Contributions (NDC)*		**Voluntary Carbon Markets (VCM)**		**Emission Trading Systems**	**LULUFC* GHG Inventory Report**	**Adaptation**	**Debt-for-Nature swap****
		Adaptation	**Mitigation**	**National**	**Local**				
Coastal Wetlands **(Blue Carbon Ecosystems)**	**Mangroves** **Seagrasses** **Tidal Marshes**	Currently not included	Currently not included	Currently not considered	Some resorts are experimenting with net-zeroing emissions with blue carbon	Currently not considered	Currently not considered	BC not included NAPA*** (2007) No NAP yet delivered	Currently not considered
	Examples	The Seychelles BC NDC-adaptation goals[623]	Costa Rica[624]	Mexico-ETS [625] an associated national land-based off-setting voluntary market	Blue Carbon project Gulf of Morrosquillo "vida manglar"[626] (Colombia) (REDD+) Delta Blue Carbon[627]	Tokyo City-ETS (Tokyo-Saitama ETS)	Singapore LULUCF[628] reporting mangroves Australia[629] and the US[630] Blue Carbon reporting	Cuba's Manglar Vivo (Mangrove-Task) NAP-Fiji[631] , NAP-Sta Lucia[632]	Seychelles,[633] Fiji,[634] and Belize[635] ongoing debt-for-nature swap through blue and green bonds
	Reefs	Included	Not relevant	Not relevant			Not relevant		Not relevant

Requested scale of reporting is National, but subnational scale accepted as interim. LULUCF (Land Use, Land Use Change and Forestry) includes emissions from forests, grasslands, wetlands, croplands, settlements and other land. Categories are defined by each country. ** Examples of nature-for-debt swaps transformed into blue and green bonds include the first blue bond ever created: the Seychelles Blue Bond, Belize's Blue Bond.*** The Maldives is not a LDC (Least Developed Country) any longer and does not require a NAPA (National Adaptation Program of Action) anymore, only NAP (National Adaptation Plan).

623 Republic of Seychelles (2021). Seychelles' Updated Nationally Determined Contribution. https://unfccc.int/sites/default/files/NDC/2022-06/Seychelles%20-%20NDC_Jul30th%202021%20_Final.pdf

624 UNFCCC. (n.d.). Nationally Determined Contributions. Costa Rica First NDC (Updated submission). https://unfccc. int/process-and-meetings/the-paris-agreement/nationally-determined-contributions-ndcs Institute of Nature Earth and Energy. (2021). Webinar en inglés: Regulated carbon markets: an opportunity for forest conservation. https://inte. pucp. edu. pe/en/noticias-y-eventos/eventos/webinar-en-ingles-regulated-carbon-markets-an-opportunity-for-forest-conservation/

625 Institute of Nature Earth and Energy. (2021). Webinar en inglés: Regulated carbon markets: an opportunity for forest conservation. https://inte. pucp. edu. pe/en/noticias-y-eventos/eventos/webinar-en-ingles-regulated-carbon-markets-an-opportunity-for-forest-conservation/

626 Conservation International. (2021). Blue Carbon Project Gulf of Morrosquillo "Vida Manglar": CCB & VCS Project Description.

627 ibid.

628 UNFCCC. (2020). Singapore. Biennial update report (BUR). BUR4. https://unfccc. int/documents/267632

629 Government of Australia (2023). Australia's 8th National Communication on Climate Change. https://www.dcceew.gov.au/about/news/australias-8th-national-communication-on-climate-change

630 United States of America (2022). The US National GHG Inventory, National Communication (NC). NC 8. Biennial Reports (BR). https://unfccc. int/documents/624756

631 Republic of Fiji. (2018). Republic of Fiji National Adaptation Plan: A pathway towards climate resilience. https://www4. unfccc. int/sites/NAPC/Documents/Parties/National%20Adaptation%20Plan_Fiji. pdf

632 Government of Saint Lucia. (2018). Saint Lucia's National Adaptation Plan (NAP): 2018-2028. Department of Sustainable Development, Ministry of Education, Innovation, Gender Relations and Sustainable Development.

633 Commonwealth. (n.d.). Case Study: Innovative Financing - Debt for Conservation Swap, Seychelles' Conservation and Climate Adaptation Trust and the Blue Bonds Plan, Seychelles (on-going). https://thecommonwealth.org/case-study/case-study-innovative-financing-debt-conservation-swap-seychelles-conservation-and

634 Fijian Ministry of Economy. (2022). Fijian Sustainable Bond Framework 2022. https://fijiclimatechangeportal.gov. fj/wp-content/uploads/2022/11/Fijian-Sustainable-Bond-Framework. pdf

635 The Nature of Conservancy. (2022). https://www.nature.org/en-us/magazine/magazine-articles/belize-blue-bonds/

Table 16. Tools, goals, requirements, and benefits of Blue Carbon Strategies

Goal	Tool	Framework	Goal	Requirement	Benefits	Gases
Commercial	NDC-Mitigation Art 6.2 (ITMOS)	UNFCCC	Inclusion of BC strategies under NDC-Mitigation planning so that mitigation in excess (out of the NDC commitment) can be transferred to other countries (Art 6.2) or it can be certified and sold under the new Climate Development Mechanism (CDM)	Monitoring system(s) to track mitigation performance (additionality from BAU baseline). This system must align with the National monitoring system(s) to track area and area changes (AD) and emissions per area unit (EF) for emission reporting.	Data collection and monitoring will help create baselines and offer an understanding of the contribution of BC ecosystems to mitigation action at national level. Funding through carbon trading Art 6.2, Art 6.4.	CO2, CH4, N2O***
	NDC-Mitigation Art 6.4 (CDM)	UNFCCC				
	NDC-Adaptation Art 6.8 (non-financial cooperation)	UNFCCC	Inclusion of BC strategies under NDC-Adaptation planning to promote coastal protection against sea-level rise and occasional extreme events (typhoon tales and tsunamis) + adaptation for food security and coastal infrastructure protection	Monitoring system to track ecosystem services and adaptation performance. Alignment with UNFCCC-NAP	BC Adaptation goals that reduce the exposure and vulnerability of island nations to the impacts of climate change are pre-requisites for Adaptation Funding. Bilateral collaboration Art 6.8	Not relevant
	Voluntary Carbon Market	Independent	Accessing external finance from the selling of certified carbon credits from activities in BC ecosystems at community and/or national levels	Monitoring system(s) to track area and area changes (AD) and emissions per area unit (EF) from BC ecosystems. Tier 2 (national data on carbon fluxes) needed. Independent Validation/Verification process needed.	Improved management of BC ecosystems by enhanced conservation and restoration activities. Enhanced ecosystem benefits.	CO2, CH4, N2O***
	ETS	Independent				
Non commercial	National GHG Inventory	UNFCCC	Inclusion of BC ecosystems into the LULUCF* sections of the national GHG Inventories	National monitoring system(s) to track area and area changes (AD) and emissions per area unit (EF) from BC ecosystems. Data on Emission Factors can initially come from standard databases (Tier 1) and be progressively improved with research on national carbon fluxes emitted or sequestered by BC ecosystems.	Data collection and monitoring will help create baselines and offer clearer understanding of the contribution of BC ecosystems to national and global emission budgets. Improved management of BC ecosystems. Opens the door to NDC funding.	CO2, CH4, N2O***
	National Adaptation Plan (NAP)	UNFCCC	Including BC adaptation goals as part of the NAP, in order to identify medium- and long-term adaptation needs and implement strategies to address those needs.	Maldives is not part of the LDC anymore. NAPAs are not a requisite any longer. NAPs are. Alignment with NDC-Adaptation. A monitoring system to track ecosystem services and adaptation performance is needed	Unlocking BC finance from Adaptation Funds	Not relevant
	National Biodiversity Strategies and Adaptation Plan (NBSAP)	CBD	Identify local priorities for biodiversity conservation and work to deliver agreed actions and targets for priority habitats and species and locally important wildlife and sites.	Monitoring system(s) to assess biodiversity and ecosystem service provision	Data collection to create baselines and to offer clearer understanding of the contribution of BC ecosystems to biodiversity, as part of co-benefits	Not relevant

* LULUCF (Land Use, Land Use Change and Forestry), includes emissions and removals from the land use sector: forests, grasslands, wetlands, croplands, settlements, and other land-use types. **Maldives has been upgraded from the LDC group. ***A stepwise approach could be implemented, starting with a simplified and incomplete GHG contribution that focused first on CO2 only. For carbon trading CH4 and/or N2O may be needed.

Any BC Strategy should be a stepwise adaptive approach where stages are constructively built upon the success of previous phases. The Maldives could move towards commercial mitigation aims in carbon markets by first aiming at adaptation and improved monitoring that help build baselines

Governmental offices at different scales (local, atoll, national) should be accountable for the previously defined goals to promote the conservation and sustainable management of mangroves, seagrasses, and tidal marshes ecosystems.

A comprehensive review of Blue Carbon options and examples of the implementation of Blue Carbon activities in other countries is provided in Table 15 and 16. Some of these options could be considered in the Maldives. Tables highlight both commercial and non-commercial BC strategies that focus on both mitigation + carbon markets (e.g., voluntary carbon markets), but also adaptation + international fundraising (e.g., under NDCs). Table 16 also offers a brief summary of the requirements and benefits of these different options for the Maldives.

3.3.2 Steps towards a Blue Carbon Strategy in the Maldives

Photo Description: Fuvahmulah Nature Park, Maldives.© World Bank

A quantitative, programmatic, and transparent BC Strategy can help investors contribute to Blue Carbon action in the Maldives.

Any BC Strategy should be a stepwise adaptive approach where stages are constructively built upon the success of previous phases. The Maldives could move towards commercial mitigation aims in carbon markets by first aiming at adaptation and improved monitoring that help build baselines. Mitigation with or without commercial aims could then be pursued. Examples of non-commercial mitigation action in the Maldives would include the reporting of BC in the National GHG Inventory (currently missing all land and coastal emissions) and including BC under mitigation goals in the NDCs. Commercial mitigation goals would include BC under national or international voluntary carbon markets, as well as compliance markets including Art 6 and International Transferred Mitigation Outcomes (ITMOs) of the Paris Agreement.

As the first step, a Blue Carbon Strategy (BCS) should address current gaps in

Blue Carbon governance to achieve BC readiness.

Step 0: BC Readiness

Defining tangible goals around Blue Carbon that provide a basis for a comprehensive and transparent Program of Action: Which ecosystems (seagrasses, mangroves, kelp-seaweed), what initiatives, what activities (restoration, conservation, avoided deforestation/degradation), in which areas, what funding is needed, what are the monitoring and performance assessment needs, and over what time period. A BC Program needs to come with a BC Plan of Action.

Creating an empowered governance structure with policies, measures, and well-defined roles and responsibilities: Governmental offices at different scales (local, atoll, national) should be accountable for the previously defined goals to promote the conservation and sustainable management of mangroves, seagrasses, and tidal marshes ecosystems.

Clarifying coastal land and carbon property rights and developing a legal context that includes specific definitions for BC management: Mangroves, seagrasses, and tidal marshes are located on coastal regions that frequently have unclear land property rights or overlap with marine state-owned territory. In the case of seagrass, Exclusive Economic Zones (EEZ) frequently complicate the property rights of deep seagrass meadows.

Building technical capacity on BC and promoting BC dialogue among stakeholders with a strong focus on community participation, women and youth leadership: This also includes creating academic disciplines in schools and universities around natural capital conservation (blue carbon ecosystems, reefs, biodiversity management), which are currently absent in the Maldivian education system

Developing baselines for BC ecosystems that capture the current status of BC ecosystems and their trends: This implies developing a national monitoring system that combines ground data collection with remote sensing tools to measure area extent, changes in area, health, carbon stocks, and carbon stock changes (fluxes) of BC ecosystems. This monitoring system must be connected with, or be part of, the national monitoring system for reporting GHG emissions and for tracking mitigation action (e.g., under the UNFCCC and Paris Agreement). BC monitoring should be connected with the monitoring of reefs. [636]

Allocating adequate budget to the readiness phase and future implementation of the BC program in the Maldives: Funding for BC can be assisted by external sources, but internal investment is a precondition to activate any BC Program, starting from the readiness (design) phase (e.g., the green tax, carbon tax payments).

636 UNFCCC. (2022). National Inventory Submissions. https://unfccc. int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/national-inventory-submissions-2022

Step 1: including BC in adaptation goals in NDCs (non-commercial):

Despite flooding and coastal erosion being key risks in the country, the Maldives has not yet included BC in its NDC adaptation goals. In its last NDC resubmission (2020),[637] the Maldives included coastal protection and fisheries, but none of them cover action on BC. Funding for BC inclusion in the adaptation goals of NDC can be obtained through several channels. Article 6.8 of the Paris Agreement allows for non-commercial bilateral cooperation that can support capacity building for adaptation. Bilateral agreements for financing adaptation through NDCs could also be established. Furthermore, Global Climate and Environment Funds such as the GEF and the GCF are designed to support adaptation activities. The Maldives has already funded adaptation projects under these funds (e.g., Advancing the National Adaptation Plan of the Maldives.)[638]

Step 2: including BC mitigation goals in the NDCs:

Including Blue Carbon targets as mitigation action in the Maldivian NDC to unlock conditional support:[639] Any mitigation action included in the NDC can be the target of international financial support. However, commitments need to rely on GHG data. A first step in this direction would be measuring and reporting BC GHG emissions under the Maldivian national GHG inventory, which remains currently absent (e.g., the Maldives does not report GHG for the land and coastal sectors, nor does it include reclamation emissions). Nearby countries like Singapore, with similar BC conditions, are already reporting their mangrove and land reclamation emissions under their national GHG Inventories.

Developing a national MRV system for GHG reporting and NDCs mitigation tracking: In order to develop a BC Strategy with mitigation commitments under the NDCs, the country needs to first establish a MRV system that helps to 1) monitor and report the GHG emissions and removals of its mangroves, seagrasses, and/or tidal marshes, including the impacts that land reclamation, deforestation/degradation, and restoration activities may have on them, 2) Support the establishment of mitigation targets and their performance assessment. Only additional emissions can be included as part of mitigation action in the NDCs and in voluntary carbon markets. This means that current levels of removals (sinks) and current carbon deposits (stocks) do not define mitigation potentials in any country. Only additional sinks and stocks in relation to the baseline will be included as mitigation action, and 3) Track the performance of any future mitigation commitment under a Blue Carbon strategy. Mitigation commitments under the NDCs need to be

637 MoECCT (2020). Update of Nationally Determined Contribution of Maldives. https://unfccc. int/sites/default/files/NDC/2022-06/Maldives%20Nationally%20Determined%20Contribution%202020. pdf

638 Green Climate Fund. (2022). Advancing National Adaptation Plan Maldives. https://www.greenclimate.fund/document/advancing-national-adaptation-plan-maldives

639 MoECCT (2020). Update of Nationally Determined Contribution of Maldives. https://unfccc. int/sites/default/files/NDC/2022-06/Maldives%20Nationally%20Determined%20Contribution%202020. pdf

consistent with the emissions reported under a country's GHG Inventory (e.g., National Communication and BUR). Currently, only two countries report their BC emissions and removals under their national GHG Inventories: Australia (Box 22) and the US. This reporting supports the tracking of BC mitigation commitments under their NDC.

Box 22. Australia's Blue Carbon and greenhouse gas accounting

Australia is one of a few countries to report human-induced greenhouse gas emissions and carbon sequestration associated with coastal forests and wetlands in their National Greenhouse Gas Inventory, using the Intergovernmental Panel on Climate Change 2013 Wetlands Supplement and the IPCC 2006 AFOLU Guidelines. It reports net emissions from extraction and regeneration of mangrove forest, conversion of tidal marsh and dredging of seagrasses.

The Australian Government funded a CSIRO-led project in 2016-17 to undertake a technical review of opportunities for blue carbon in the Emissions Reduction Fund (ERF). The report identified likely sequestration opportunities and key factors that influence carbon storage, cycling and emission in Australian mangrove, tidal marsh and seagrass ecosystems. The Department is now scoping those opportunities for ERF method development in conjunction with relevant stakeholders.

Currently, the Premier's Climate Change Council is developing an across-government agency Climate Change Strategy to reduce net emissions. It is also developing a Blue Carbon Strategy for South Australia . The strategy will position South Australia to lead further initiatives on policy and carbon crediting mechanisms, guide programs for scientific research and undertake projects that demonstrate feasibility, costs and multiple co-benefits of Blue Carbon.

Step 3: including BC in mitigation carbon markets:

BC can be included in mitigation carbon markets, in particular Compliance Carbon Markets (e.g., trading mitigation achieved under NDCs commitments through ITMOs under Art 6.2 of the Paris Agreement), International Carbon markets (e.g., Art. 6.4 Mechanism of the Paris Agreement), or Voluntary Carbon Markets (e.g., VERRA, Plan Vivo, American Carbon Registry). The difference between international and independent carbon markets is explained in the World Bank Report on Carbon Pricing.[640] Any mitigation initiative needs to show additionality to what would have otherwise happened in the absence of the project (business as usual). Additionality defines the amount of credits that can be sold and the viability of the project (small expensive projects with little additionality are unlikely to be financially viable). Additionality is monitored and traced with the support of an MRV system (e.g. by satellite + ground data collection) and once verified/certified by an independent validation/verification body, credits are recorded in a registry (e.g., UNFCCC registry, international voluntary carbon market registry, and national carbon registry) and can be sold as a carbon credit for offsetting (or other co-benefit) reasons.

3.4 Recommendations

This section provides several overarching recommendations in addition to the recommendations provided in previous sections of this chapter.

Short-term recommendations

Perform baseline ecological and socio-economic assessments of established PAs, sensitive areas as well as potential areas for the establishment, management, and monitoring of PAs. This will help ensure current and new streams of funding (e.g., from the Green Fund (Section 3.2.2) and bond proceeds (Section 5.3) are allocated to areas where conservation is most needed. The need for conservation depends, among other things, on the presence of vulnerable and/or threatened species and the presence of drivers of ecological degradation (see e.g., Sections 2.1.1.1 and 2.1.2 for the drivers of coral and mangrove degradation).

Review the categorization of PAs by ecosystem type so that the progress in achieving the SAP and NBSAP protection targets can be measured. Accurate ecosystem type definitions and protected area estimates for each type are needed to verify progress toward these targets. More broadly, a detailed study of mangroves and wetlands within and outside PAs is needed as there is very limited information on the distribution of mangroves and wetlands.

640 World Bank. (2023). State and Trends of Carbon Pricing. https://doi.org/10. 1596/39796

Develop a medium-to-long-term financial plan that specifies how the declaration and management of MPAs will be funded. This plan should be informed by a spending analysis of PAs where management plans are implemented. Furthermore, additional funding for the declaration and management of MPAs should be identified and earmarked. Additional funding could be obtained from the Green Fund, of which currently a negligible share is spent on conservation (see Section 3.2.2). PA management could also be funded by attracting private capital with the issuance of (unrestricted) use-of-proceeds bonds (see Section 5.4), and by establishing a Conservation Trust Fund.

Improve the capacity to monitor visitor numbers and impacts, especially at PAs where high visitation rates are visibly damaging marine wildlife, such as in SAMPA.[641] An increased interest in PA visitation compared to 5 years ago is reported by 55 percent of resorts,[642] suggesting that the capacity to monitor visitors is becoming increasingly important. Links between users, tourism operators, communities, and enforcement authorities can be strengthened to better manage such impacts. Strengthening stakeholder engagement through the establishment of formal committees or working groups has been identified as a need at Hanifaru Bay to increase participation and sense of ownership of locals in the PA management.

Develop and implement proper management plans for the 74 PAs that are currently without management plans. The management plans should cover:

- The establishment of a management office/authority with adequate staffing and other infrastructure and equipment,
- A sustainable financing model to support management,
- Staff trained and involved in awareness raising and educating people, monitoring visitor numbers and activities and enforcing management rules of the PA,
- Data collection for PA ecosystem health and visitation.

Expand the number and extent of MPAs. Currently only 5 percent of Maldives' territorial waters and 1 percent of archipelagic waters are protected. The identification of Key Biodiversity Areas would help prioritize areas where protection is most needed in terms of biodiversity levels. The current OECM recognition should also be expanded to include community conservation areas to encourage community initiatives that can complement national efforts in terms of biodiversity conservation.

641 Alberts, E. C. (2021). Boat strikes in Maldives put pressure on whale sharks' survival odds. Mongabay News and Inspiration. Nature's Frontline. https://news. mongabay.com/2021/01/boat-strikes-in-maldives-put-pressure-on-whale-sharks-survival-odds/

642 World Bank & Ministry of Tourism led Environment and Climate Survey of Resort Islands (2023)

Photo Description: Busy road in Male, Maldives.© Gilbert Pagunaling /Unsplash

Devise a Blue Carbon Strategy to leverage the benefits of natural capital conservation and restoration and help unlock international financial support. The Maldives does not currently include BC in its National GHG Inventory and its NDCs. The development of a well-developed and reliable BC Strategy could attract investors. The region counts on some advanced BC strategies, and there are international examples (e.g., Australia) to support the Maldives in building its own BC strategy and the required elements, such as an MRV system and a registry. Improvements in environmental governance are a prerequisite for BC strategies to be successful (see Chapter 4). Explore the possibilities for including algae in blue carbon projects (kelp and seaweed farming) and their associated commercial purposes (e.g., cosmetics and food industries). This could be done by engaging in South-South dialogue with Zanzibar and other Indian Ocean experiences. The Maldives could also participate in the development of VERRA's methodology for seaweed and kelp carbon farming.[643]

Medium- to long-term recommendations

Facilitate the increased involvement of Island and Atoll Councils in conservation with a supporting policy framework. Under the Environment Protection and

643 Verra. (2023, April 4). Methodology for Creation of Seaweed or Kelp Farms - Verra. https://www.verra.org/methodologies/methodology-for-creation-of-seaweed-or-kelp-farms/

Preservation Act, the Ministry of Environment, Climate Change, and Technology is responsible for identifying MPAs, while Island Councils can advocate for protection within their jurisdictions (See Section 4.1.2.). New decentralized governance models that consider the various roles and responsibilities of the central government, local councils, and communities need to be explored. Island communities are heterogeneous in terms of resource engagement, community structure, relations, and governance mechanisms. Therefore, a governance model that can be adapted to different communities needs to be developed.

Strengthen the national policy framework for the development of eco-tourism. While Island Councils have the autonomy to generate revenue through the use of marine resources, there is a continued high interest in tourism development within their jurisdictions. In order to mitigate the potential negative impacts on the environment, Councils need to be provided with national ecotourism guidelines. These guidelines should pay particular attention to engaging local communities and education.

Leverage the increasing demand for nature-based tourism while mitigating the negative impacts on the marine environment. This may be done by more actively promoting MPA excursions that adhere to the highest standards in terms of environmental sustainability. Such standards should minimize the potential negative impacts of visitation on marine ecosystems and wildlife in MPAs. Implement the responsible visitor program identified in the Fifth Tourism Master Plan, which includes ranger training and awareness programs to educate PA visitors.

Allocate more Green Tax proceeds to conservation projects. Natural capital is the driver of Green Tax revenues. Allocating a higher share of the proceeds to natural capital conservation would contribute to the continuity of this important stream of government revenue.

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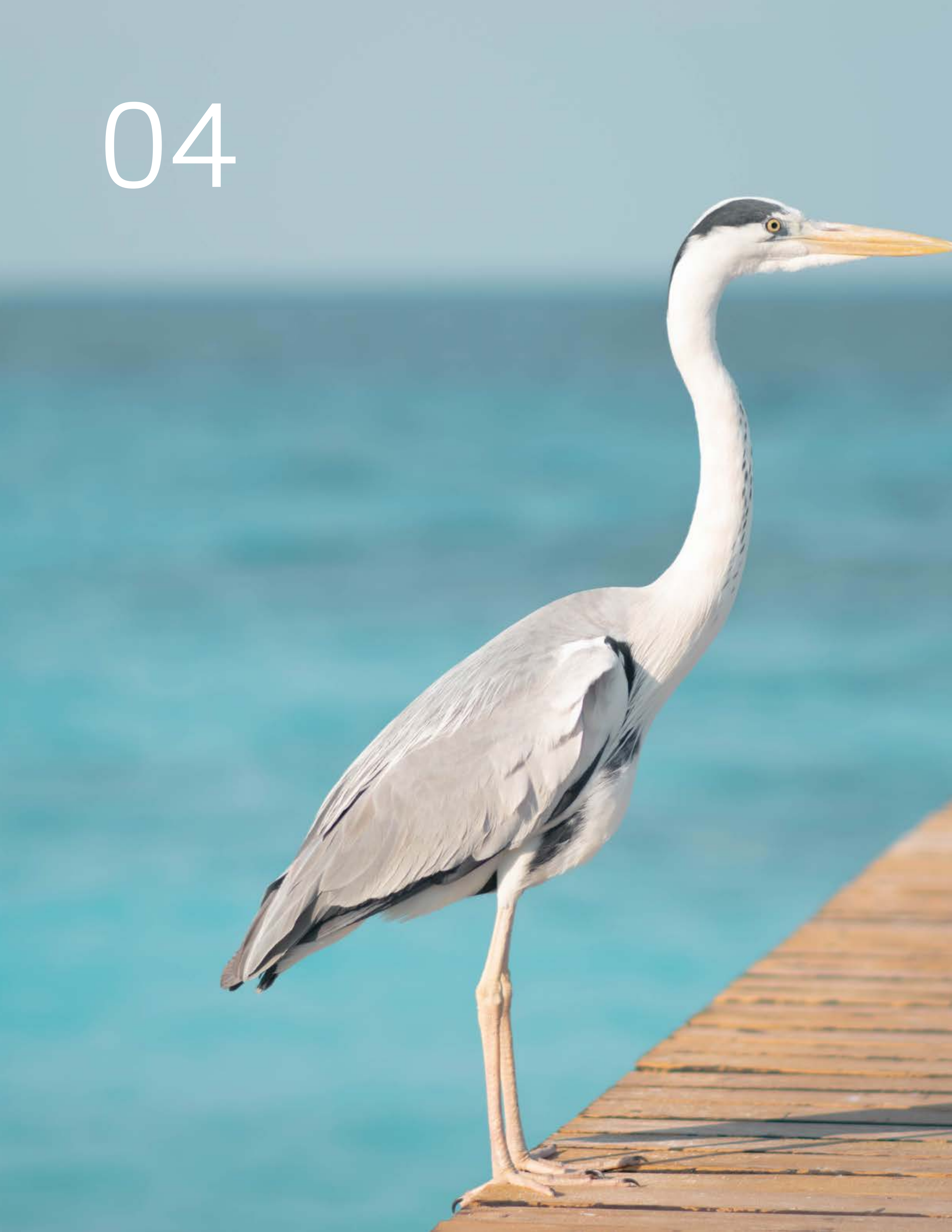


Natural Resource and Environmental Governance and Institutions

4.1 Overview of environmental governance in the Maldives

Over the past five years, the Maldives has implemented numerous strategies and policies related to Environmental Governance. The primary law governing this area is the Environmental Protection and Preservation Act (EPPA) Act No 4/93, enacted in 1993, which serves as the umbrella legislation for the protection and sustainable management of the country's natural resources. To bolster these efforts, several policies and strategies have been implemented. The last National Environmental Action Plan (NEAP) was developed for 2009-2013, representing the third iteration of the plan. However, a new NEAP has not been put in place for over a decade.[644] The following policies and strategies have been developed by the MoCCEE over the last decade:

- Maldives National Energy Policy and Strategy (2010)
- Maldives Climate Change Policy Framework 2015
- National Biodiversity Strategy and Action Plan (NBSAP)- 2016-2025
- Solid Waste Management Policy (2015)
- National Solid Waste Management Policy (2016)
- National Health Care Waste Management Policy (2016)
- Maldives' National Action Plan on Air Pollutants (2019)
- Waste Management Act (24-2022)

644 Republic of Poland. (2008). The National Environmental Policy For 2009-2012 And Its 2016 Outlook. https://wedocs. unep. org/bitstream/handle/20.500.11822/9597/-The_National_Environmental_Policy_for_2009-2012_amd_Its_2016_Outlook-2008Poland_NATIONALE. pdf?sequence=3&isAllowed=y

Environmental Governance in the Maldives is implemented through a comprehensive law, Law No.4/93 Environment Protection and Preservation Act (EPPA), which was enacted in April 1993.

Several action plans with a focus on solid waste management and the phased discontinuation of plastic usage have been prepared over the past decade. Detailed information about these action plans is presented in section 2.4.

4.1.1 The legal framework

4.1.1.1 The Environment Protection and Preservation Act (EPPA)

Environmental Governance in the Maldives is implemented through a comprehensive law, Law No.4/93 Environment Protection and Preservation Act (EPPA), which was enacted in April 1993. According to the EPPA, "environment" encompasses all living and nonliving things that impact human lives, and a "project" refers to any activity aimed at achieving specific social or economic goals. The EPPA emphasizes that the natural environment and its resources are national treasures that require protection and preservation for the welfare of future generations. Ensuring the protection and preservation of the country's land and water resources, flora and fauna, as well as beaches, reefs, lagoons, and all natural habitats, is deemed crucial for the sustainable development of the Maldives.

According to EPPA, the Ministry of Climate Change, Environment and Energy (MoCCEE) is designated as the primary agency responsible for formulating policies, as well as developing necessary regulations and guidelines to enact the EPPA.[645] The EPPA also explicitly refers to Protected Areas and Natural Reserves, allocating responsibility to the MoCCEE for identifying such areas and establishing requisite rules and regulations for their protection and preservation. Any party seeking to designate an area as a protected area or reserve must register it with the Ministry. This provision enables Island Councils to advocate for the protection of natural landscapes, both terrestrial and marine, within their jurisdictions via the MoCCEE.

4.1.1.2 Environmental Impact Assessment Regulation (No. 2012/R-27) and Amendments

Environmental Due Diligence in the Maldives is governed by the Environmental Impact Assessment Regulation (No. 2012/R-27), as mandated by Article 5 of Act No: 4/93 of EPPA. This specific regulation regarding the preparation of an EIA report provides a detailed process, outlined in Schedule A of the Regulation, for proponents, consultants, government agencies, and the public to obtain approval for a Development Proposal in the form of an Environmental Decision Statement (EDS). The EP) implements this regulation on behalf of MoCEE. Since its enactment, the regulation regarding the preparation of an EIA report has undergone numerous amendments, primarily concerning the revision of

645 EPA. (2016). Environment Protection and Preservation Act of Maldives: Law No: 4/93. http://www.environment.gov.mv/biodiversity/wp-content/uploads/2016/01/environment_protection_and_preservation_act_1993_english. pdf

The EIA report regulation applies to all types of projects in the Maldives. It requires the project proponent to acquire an Environmental Decision Statement as permission to commence the project.

the Ministry of Environment's title, which has been adjusted several times in response to changes in the government regime.[646] There is a current series of amendments underway and expected to be completed prior to the close of calendar year 2023.

The EIA report regulation applies to all types of projects in the Maldives. It requires the project proponent to acquire an Environmental Decision Statement as permission to commence the project. The regulation outlines the procedures and requirements for the application and issuance of an Environmental Decision Statement. The primary requirement is either to submit a screening form or conduct an Initial Environmental Examination (IEE) and/or EIA, depending on the scale and potential environmental impact of the project.

Under Article 5, the EPA mandates that any development work or project that significantly impacts the environment must obtain EIA approval from MoCCEE. The EIA regulation outlines the procedure to secure environmental approval for development projects, specifying which projects require an EIA (Schedule D), those exempt from an EIA (Schedule T), and those that can proceed in accordance with the EPA's mitigation plan (Schedule U). The purpose of the EIA, according to the regulation, is to ensure potential environmental impacts are anticipated and addressed before issuing the Environmental Decision Statement. All other projects undergo a screening process, outlined in Article 8 of the regulation, following which the EPA determines the required level of assessment. Depending on the project's potential environmental impact, the EPA may require an EIA, an Environmental Management Plan (EMP), a project to proceed with a mitigation plan or determine that the project can move forward without any assessment.

The regulation provides a detailed process for projects that require an EIA in Article 11, which includes scoping. Following this scoping process, a term of reference will be issued to guide the level of assessment required for the project. It's mandatory in the Maldives that an EIA is prepared by a consultant who is registered with the EPA, as per Article 16 of the regulation. The registration process for these consultants is administered by a consultant registration board, the functions and composition of which are outlined in Article 17 of the regulations.

Upon the submission of an EIA report, the EPA sends it to two independent reviewers for assessment, according to Article 13 of the regulation. This review process can take anywhere between 5 to 15 days. After the review, the EPA informs the project proponent whether any additional information is needed, or if the project can be approved, or if the EIA report should be rejected, or if the project needs to be dismissed due to its potential for irreversible damage to

646 World Bank. (2023). Maldives Environmental and Social Framework Overview and Gap Assessment. https://documents. worldbank.org/en/publication/documents-reports/documentdetail/704671468120862385/maldives-environmental-management-project-environmental-and-social-assessment-framework

The EIA regulation applies to all development projects, however, the level of assessment to be carried out in order to acquire an Environmental Decision Statement depends on whether the project falls under the list indicated in Schedule D or not.

the environment. Procedures for appealing the decision are outlined in Article 15, with the Minister of Environment ultimately making the appeal decision. Non-compliance fines and penalties are specified under Article 20.

4.1.1.3 Coverage of the EIA system & its requirements

The Environmental Impact Regulation includes a list of project types, as indicated under the Schedule D. For all the project types listed under the schedule D, the proponents must submit an EIA application for as indicated in the schedule C2 of the regulation. The EIA regulation applies to all development projects, however, the level of assessment to be carried out in order to acquire an Environmental Decision Statement depends on whether the project falls under the list indicated in Schedule D or not. Subsequently, based on the review of the EIA application form, the Ministry will decide and advise the proponent of whether to submit an Initial Environmental Examination Study or undertake an EIA. For those projects that are not included under Schedule D, a screening form, as indicated under schedule C1 of the regulation, must be submitted to the Ministry for review. The subsequent decision may require an Environmental Management Plan or request additional information in the form of an IEE study. The regulation only provides a list of project types in Schedule D without any specific categorization. Projects not included in Schedule D are obliged to submit either a screening form or an IEE study based on guidance from the Ministry.

4.1.1.4 Environmental Decision Statement (EDS) to allow development projects

In cases of noncompliance or breach of the conditions of Environmental Decision Statement, the Ministry reserves the right to issue a cessation order and take direct action to remedy the environmental damage identified and recover the cost of such remedial work from project proponents.

All projects in the Maldives require permission from the EPA before they can proceed. The regulation for the preparation of an EIA report outlines the process for obtaining an Environmental Decision Statement (EDS). Projects that fall under Schedule D, as stated in the regulation, require the proponent to apply for an EDS. The Ministry reviews the form and advises whether an IEE or a full EIA is needed. For projects not listed under Schedule D, the proponent submits a screening form for review, and the Ministry advises if an EMP is sufficient or if an IEE is needed. If the Ministry finds that the project could cause irreversible or unacceptable environmental damage during the review of the EIA Application Form, they may advise that the project be dismissed or revised. In both cases, the Environmental Decision Statement comes with a set of conditions for EMP compliance and reporting requirements. In cases of noncompliance or breach of the conditions of Environmental Decision Statement, the Ministry reserves the right to issue a cessation order and take direct action to remedy the environmental damage identified and recover the cost of such remedial work from project proponents.

4.1.2 The organizational structure for implementing environmental governance

4.1.2.1 The Ministry of Climate Change, Environment and Energy (MoCCEE)

The MoCCEE in the Maldives is responsible for the protection and preservation of the environment. Their mandate includes implementing government policies, regulations, programs, and projects associated with providing clean water and suitable sewerage services. Additionally, they are tasked with ensuring access to clean, affordable energy services and maintaining a clean, healthy environment free from pollution. The Ministry also oversees the protection of islands from coastal erosion and advocates for the rights of small island states in the fight against climate change. Furthermore, they are responsible for mobilizing finance to mitigate and adapt to the adverse impacts of climate change, coordinating sustainable development goals within the government, and safeguarding and preserving the natural environment (see Table 17 for a comprehensive picture of the institutional landscape).

Table 17. Institutional landscape of environment and natural resource governance in Maldives

Institution	Description
Ministry of Environment, Climate Change and Technology (MoECCT)	The main body overseeing environmental governance, technology, and climate change policy in the Maldives.
Environmental Protection Agency (EPA)	An agency under MoECCT, responsible for the enforcement of all laws and regulations pertinent to environmental protection, biodiversity conservation, waste management, and pollution prevention.
Baa Atoll Biosphere Reserve Office	An office under the MoECCT, managing the Baa Atoll Biosphere Reserve.
Utility Regularly Authority (URA)	An authority under the MoECCT, responsible for regulating utility services.
Maldives Meteorological Service (MMS)	An agency under the MoECCT, providing weather forecasting and monitoring services.
National Center for Information Technology (NCIT)	An agency under the MoECCT, responsible for managing and developing information technology initiatives.
Communications Authority of the Maldives	An agency under the MoECCT, responsible for overseeing the country's communications industry.
Technical Departments under MoECCT	These departments focus on various areas of environmental and natural resource management.
Local Government Authority (LGA)	It oversees the local governance in the Maldives.
Atoll Councils	Under the LGA, these councils govern at the atoll level and are accountable to the LGA.
Island Councils	Under the Atoll Councils, these councils are responsible for governance at the island level and are accountable to the Atoll Councils.
Women's Development Committee	A committee established under the Island Councils, responsible for providing input to the council about various development activities within the island.

Requested scale of reporting is National, but subnational scale accepted as interim. LULUCF (Land Use, Land Use Change and Forestry) includes emissions from forests, grasslands, wetlands, croplands, settlements and other land. Categories are defined by each country. ** Examples of nature-for-debt swaps transformed into blue and green bonds include the first blue bond ever created: the Seychelles Blue Bond, Belize's Blue Bond.*** The Maldives is not a LDC (Least Developed Country) any longer and does not require a NAPA (National Adaptation Program of Action) anymore, only NAP (National Adaptation Plan).

The following government agencies are affiliated and function under the direct supervision of the MoCCEE. The EPA, the Baa Atoll Biosphere Reserve Office, the Utility Regularly Authority (URA), The Maldives Meteorological Service (MMS), the National Center for Information Technology (NCIT), and

The EPA is mandated to implement regulatory activities for the protection, conservation and management of environment and biodiversity, as well as waste management and pollution prevention under the Environment Protection and Preservation Act (4/93).

the Communications Authority of the Maldives. In addition, the Ministry has 6 technical departments that focus on various areas of environmental and natural resource management.

4.1.2.2 The Environmental Protection Agency (EPA)

The EPA is responsible for the implementation and enforcement of all laws and regulations relevant to environmental protection and is thereby a regulatory entity. The EPA was established in 2008 when the Environmental Research Centre and Maldives Water & Sanitation Authority was merged by the president's decree. The EPA is mandated to implement regulatory activities for the protection, conservation and management of environment and biodiversity, as well as waste management and pollution prevention under the Environment Protection and Preservation Act (4/93). The EPA also regulates Municipal Water Supply and Sewerage services under the Public Services Act (4/96).

As per the EPPA, the EPA, as the concerned government authority, is obligated to provide the necessary guidelines and advise on environmental protection in accordance with the prevailing conditions and needs of the country. The main functions of the EPA in regard to the EIA system are as follows: (i) to issue guidelines and standards of the EIA; (ii) to administer the environmental permission process on any project proposal covered under the system; (iii) to review the environmental aspects of project proposal based on the IEE or the EIA report, field visits and other related documents required of the project proposal; and (iv) based on the review, to grant or deny EDS to the project proposal. For reviewing project proposals' EIA reports, EPA sends the review to two independent reviewers as indicated under the regulation. Following review, EPA informs the proponent if any additional information is required, if approval can be given for the project, if the EIA report needs to be rejected, or if the project needs to be rejected due to irreversible damage to the environment. In addition, the EPA also partakes in research and development activities focused on biodiversity conservation and is responsible for overall environment compliance and quality monitoring for the whole of the Maldives.

In accordance with the Decentralization Act passed in April 2010, governance within the Maldives is structured such that Island Councils are accountable to Atoll Councils, which in turn answer to the Local Government Authority (LGA).

4.1.3 The role of Island Councils (ICs) in environmental governance

In accordance with the Decentralization Act passed in April 2010, governance within the Maldives is structured such that Island Councils are accountable to Atoll Councils, which in turn answer to the Local Government Authority (LGA). As mandated by the Constitution, these Councils are tasked with ensuring democratic and accountable governance; fostering social and economic well-being and development within their communities; and establishing safe, healthy, and ecologically diverse environments. Financially, the Constitution enables Councils to receive grants from the central government as well as raise their own revenues. As local-level entities, Island Councils, Atoll Councils, and City Councils carry an additional mandate to facilitate the implementation

The Island Councils under the Decentralization Act in Maldives are vested with the responsibility of safely disposing waste at the island level, ensuring no inconvenience is caused to the community.

of Environmental Governance measures. This includes enacting policies, strategies, and regulations in collaboration with the central Government. This synergistic approach promotes a more holistic, multi-level response to environmental challenges and ensures local conditions and needs are accounted for in decision-making processes.

Chapter 4 of the Decentralization Act gives island councils specific powers and responsibility for, amongst other things:

- Administering and developing the island in accordance with the Constitution and statutes and providing municipal services as prescribed in this Act.
- Preparing island development plans in consultation with the community and submitting the plan to the Atoll Council.
- Implementing development projects planned and assigned by the government in line with the island development plans formulated by islands and submitted to the Atoll Councils.
- Assisting Government Ministries and Atoll Councils in monitoring the progress of various development projects.
- Formulate island level policies necessary to discharge the powers and responsibilities conferred to the island council by this Act and formulate and implement required regulations for the purpose.

The Island Councils under the Decentralization Act in Maldives are vested with the responsibility of safely disposing waste at the island level, ensuring no inconvenience is caused to the community. This involves providing specific services to the island residents, for which they have the authority to charge a fee or rent. The determination of these fees is carried out in consultation with the local community and in accordance with the laws of Maldives. Chapter 14 of the Act further grants the Island Councils the power to formulate regulations that fall within their jurisdiction, provided they seek advice from the LGA. This includes the ability for city councils, atoll councils, and island councils, under the advice of the LGA, to establish regulations specific to waste management and disposal on their respective islands.

The Act has undergone a number of revisions, the most recent of which was in 2019. The key aspects covered in this revision are highlighted below:

As per article 68 of the act, any development project undertaken on an island requires consultation with the council and other relevant authorities established on the island. It also mandates that any EIA reports prepared for a project must be shared with the council, ensuring that information about the impacts and mitigation measures is effectively disseminated.

Article 107-1 requires the council to hold meetings with the public regarding any important development activities undertaken on the island. The time and location of such meetings must be publicly announced at least five days prior.

Article 56-6, stipulates the establishment of a Women's Development Committee, with its members chosen through an election involving the women of the community. Following Article 56-7, this committee is tasked with providing valuable insights to the council about different development initiatives within the island.

4.2 Barriers to environmental due diligence

The Maldives currently lacks a comprehensive National Environmental Action Plan (NEAP), with the previous one dating back more than a decade. Despite various initiatives and action plans supported by policy, the absence of a unifying action plan that encompasses the multifaceted nature of environmental challenges can hamper the effective implementation of overall environmental policies and strategies. A well-constructed NEAP could enhance the country's environmental management capacity and natural resource conservation, promoting sustainable development. This plan could provide the necessary tools, projects, and programs for strategic environmental and natural resource management, aiming to enhance the population's living environment and quality. Such a plan could link with current initiatives on solid waste management, air quality, and pollution control. Further, a NEAP could foster an environmental ethic by elevating public awareness, particularly within grassroots communities, about environmental issues and by facilitating the mobilization of national and international resources for the funding of investment projects and programs.

Coverage and Applicability of the Legal Framework. While the Maldives has a strong policy and legal framework, challenges exist with the enforcement and implementation of environmental management.[647] The EPPA (4/93) is over 20 years old and the EIA system demands further enhancement to align with the country's evolving developmental trajectory and environmental and social challenges. The due diligence procedure needs to inform the nation's planning systems to ensure overall planning and implementation of physical development does not come at the cost of the environment and informs design and the planning process. The current scope and applicability of both the EPPA and EIA regulation offer limited provisions about the comprehensive attributes an ideal EIA should have (see Table 8 for a describtion of the process), particularly when it comes to identifying potential impacts on specific key thematic areas. These areas will be discussed in detail in the subsequent paragraphs.[648]

647 ibid.

648 ibid.

Table 18. Stages of the EIA Process in the Maldives

Stage of EIA Process	Description
Project Proposal	The project proposal is evaluated to determine whether it falls under the list of projects specified in Schedule D of the EIA regulation. If it does, an EIA is required. If it doesn't, a screening form is submitted.
Site Screening	All development proposals are subject to site screening according to the EIA regulation. This generally involves a basic analysis of the project site and its immediate surroundings.
Impact Assessment	This involves the identification and evaluation of potential environmental impacts of the project. Currently, the scope of the assessment is generally limited to the immediate project site and its surrounding area (usually a 1-2 km radius).
Mitigation Hierarchy	While not explicitly required in the current regulation, international best practice encourages the adoption of a mitigation hierarchy: avoidance, minimization, mitigation, and finally compensation or offset.
Review	Once the EIA report is completed, it is sent to the EPA for review. The EPA then sends it to two independent reviewers. Based on the review, the EPA will request additional information, give approval, reject the EIA report, or reject the project due to potential irreversible damage to the environment.
Public Consultation	Any important development activities undertaken on the island should be discussed in public meetings. The timing and location of these meetings must be announced at least five days prior.
Approval	Once the EIA report has been reviewed and all concerns have been addressed, the EPA can grant an Environmental Decision Statement (EDS), giving approval for the project to proceed.

The current EIA regulation in the Maldives does not encompass the evaluation of policies, plans, and programs. Furthermore, the EPPA lacks specific provisions to ensure that policies, plans, and programs are subjected to environmental and social due diligence, alongside projects. This underscores the fact that the Maldives' EIA system is regulations-based, focusing on addressing direct impacts of tangible activities on the ground rather than broad-spectrum interventions, which encompass policies, plans, programs, and not just direct impacts, but also future indirect and cumulative impacts. By scrutinizing policies, plans, and programs under an environmental lens, potential impacts to both the environment and communities can be identified earlier. This proactive approach facilitates the designation of sensitive or restricted areas, and promotes more thoughtful planning for physical interventions, thereby mitigating harm and enhancing environmental outcomes and benefits. Concepts such as Best Practicable Environmental Option Studies (BPEOs) and Strategic Environmental Assessments (SEAs) fall under this broader approach.

With the Maldives' current development direction and its sensitive environmental context, more comprehensive EIAs are necessary. Presently, all development proposals undergo site screening per the EIA regulation, but the depth and level of these assessments depend on whether the project is included under Schedule D. Projects listed under Schedule D require a full EIA, while those not covered must submit a screening form. However, the scope of these assessments, in both cases, is confined to the project site and its immediate surroundings, often just a 1-2km radius. This limitation results in EIAs frequently overlooking larger impact areas, which is crucial in coastal and marine ecosystems where the effects of coastal development can span a substantial distance. Moreover, potential cumulative impacts are not considered. For instance, a resort development near an inhabited island might assess impacts on the resort's island, but not the nearby inhabited island. Such oversight could result in significant environmental issues, such as altered current patterns due to coastal changes or harbor development, leading to erosion or seasonal coastal dynamics alterations on neighboring inhabited islands.

The existing EIA regulation in the Maldives does not explicitly mandate a hierarchical approach when deciding on the management measures to apply to an environmental impact or risk. Ideally, this hierarchy should prioritize avoidance, followed by minimization, then restoration, and finally offsetting, to effectively manage and control any negative effects of development on the environment.[649] While the existing regulation does stress the consideration of alternative analyses during the EIA process, and the Ministry maintains the right to reject projects deemed critically harmful, it falls short in embracing the mitigation hierarchy rule consistently followed in international best practices for EIAs. This rule prioritizes firstly avoidance, followed by minimization, then mitigation, and finally compensation or offsetting. Incorporation of this hierarchy approach into the EIA process in the Maldives is thus essential.[650]

Public Participation in the EIA process and overall environmental policies and programs. A more decentralized participative and consultative approach in developing environmental policies, strategies, and action plans is now in place. Currently, some environmental issues that have direct impacts on the communities or from communities are consulted on widely.[651] However, public participation during the implementation of development projects is not fully established and should be explored by the government for better environmental stewardship. Regarding EIAs, the consultation process is currently limited to the preparation phase, and there are no specific requirements for public involvement during project implementation. The regulation mandates public consultations for development projects, but for more complex projects, public inputs are sought before an Environmental Decision Statement (EDS) can be issued. Proponents are notified to organize public meetings at designated locations determined by the MoCCEE. Additionally, a complaint mechanism allows affected individuals to submit their concerns, which are then reviewed by the EPA, followed by appropriate action. Completed EIAs are publicly disclosed on the EPA's website and have

649 Evans, T. M. , Wingard, J. M. , & Humle, T. (2021). The mitigation hierarchy in environmental impact assessment and related legislation as a tool for species conservation: A case study of western chimpanzees and mining development. Biological Conservation, 261, 109237. https://doi.org/10. 1016/j. biocon. 2021. 109237

650 Babu, V. a. P. B. S. (2020). Mitigation Hierarchy: Levels of mitigation in Environmental Impact Assessment. Eco-intelligentTM. https://eco-intelligent.com/2016/12/11/levels-of-mitigation-in-environmental-impact-assessment/

651 World Bank. (2023). Maldives Environmental and Social Framework Overview and Gap Assessment. https://documents. worldbank. org/en/publication/documents-reports/documentdetail/704671468120862385/maldives-environmental-management-project-environmental-and-social-assessment-framework

been accessible to the public for the past decade. Interested parties can easily access the full reports or summaries of key findings. A summary of key findings of the status of Public Participation in the EIA process in line with the EPPA and during project preparation and implementation is presented in Table 19 below.

Table 19. A Summary of public participation in the EIAs in the Maldives as defined in the EPPA [653]

Key Area of Public Participation	Provisions as per EPPA
Public Scoping:	Members of the public are not involved in scoping. The Ministry may invite representatives from other relevant authorities. Regulation, sec. 11(b).
Public Review of TOR	The public does not partake in the review of TORs
Public Participation Opportunities:	The regulation on preparation of EIAs requires public consultations for development projects however for more complex projects, it is required to ask for public inputs before an EDS can be issued, therefor, the proponent is notified to arrange a public meeting or hearings. Final EIAs are publicly disclosed and open to the public for review via the EPA website
Public Meetings:	"Some projects may be sufficiently controversial or complex to require further public input before an Environmental Decision Statement can be issued; in such instances the proponent will be notified and requested to arrange, and pay for a public meeting or meetings at a location or locations to be determined by the Ministry." Regulation, sec. 13(g).
Criteria to Hold Public Meeting:	Ministry or agency has discretion to decide whether to hold a meeting and/or hearing
Public Input at Meeting:	The EIA Regulation does not describe public participation requirements in any detail. It is unclear whether members of the public may make their views known at public hearings.
Criteria to Hold Public Meeting:	Ministry or agency has discretion to decide whether to hold a meeting and/or hearing
Days for Public to Review Final EIA:	10 days
Public Comments on Draft EIA:	No Provisions
Public Comments on Final EIA:	"The Ministry shall accept comments from the relevant ministries and authorities and the public on the Environmental Impact Assessment Report under review for a period of ten (10) working days after it is available for public viewing." Regulation, sec. 13(d).
Response to Public Comments:	"In issuing the Environmental Decision Statement the Ministry will take in to account the comments received from the general public for the Initial Environmental Examination or Environmental Impact Assessment under review." Regulation, sec. 13(e)
Facilitation of Public Participation:	No provisions or guideless to consultation on facilitation of public participation. In doner funded programs such the World Bank, ADB etc. stakeholder consultations and public consultations are conducted in line with the respective agencies policies but focused on a particular project or program.
Citizen Judicial Review of EIAs	"Where the rights of a person, a group or community has been adversely affected by administrative action, every such person, group or every person who may be directly affected by such action has the right to submit the matter to court." Article 43(c) of the Constitution. Schedule 5 of the Judicature Act of the Maldives vests jurisdiction of these proceedings with Magistrate Courts.
Project Monitoring:	Summary monitoring reports are submitted at 2-month intervals during site preparation, construction and decommissioning phases. Regulation, Schedule N. Penalties may be assessed if monitoring requirements in the Environmental Decision Statement are not fulfilled. Regulation, sec. 20(3). The Minister may authorize an enforcement officer to monitor a project's impacts. Regulation, sec. 23.
Enforceability of EIA Detail:	There are no provisions in the EIA Regulation allowing citizens or Non-Governmental Organizations (NGOs) to enforce the terms and conditions of an Environmental Decision Statement.
Enforceability of Project Permit	There are no provisions in the EIA Regulation allowing citizens or NGOs to enforce the terms and conditions of an Environmental Decision Statement.

652 Zuhair, M. H. (2015). An Evaluation of Public Participation in the Environmental Impact Assessment Process of the Maldives (Thesis, Master of Management Studies (MMS)). University of Waikato, Hamilton, New Zealand. https://hdl. handle. net/10289/9374

The number of development projects seeking Environmental Clearance from the EPA in the Maldives has shown a clear upward trend over the years.

4.3 Trend analysis

In the past five years, a significant number of due diligence instruments, totaling over 1,263, have been prepared for development projects seeking environmental clearance. Of these, a majority have been EIAs, as mandated by the national requirements outlined in the EPPA. Almost all of the Environmental and Social Management Plans (ESMPs) and Environmental Management Plans (EMPs) have been done for donor-financed programs where a Project has agreed with the EPA to use such an instrument as doner agency Environmental and Social Policies or standards typically require due diligence for activities beyond the standard areas the EPPA warrants due diligence for, including smaller scaled projects that involve physical interventions (Table 20).

Table 20. Due diligence for development projects from 2015 to February 2023

Year	Instrument Type (ESIA, EIA, ESMP etc.)			
	EIA	ESMP	EMP	Total
2015	41	0	1	42
2016	130	1	0	131
2017	120	0	9	129
2018	106	0	13	119
2019	147	3	28	178
2020	109	0	6	115
2021	212	15	12	239
2022	251	0	15	266
2023	42	0	2	44
Subtotal	**1158**	**19**	**86**	**1263**

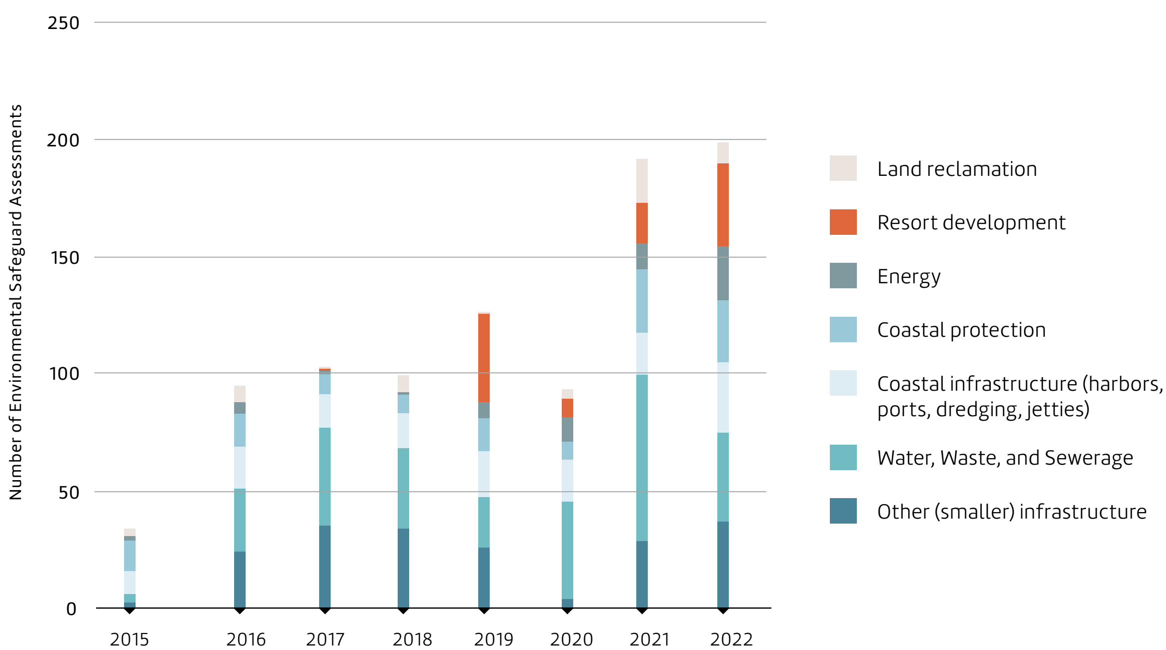
Source: Ministry of Finance 2022. Green Fund Report. https://policy.asiapacificenergy.org/sites/default/files/Maldives%20INDC%20.pdf

While there was a temporary decline in 2020 due to the COVID-19 pandemic and the associated travel restrictions, the years 2021 and 2022 have witnessed a rapid increase in the number of projects.

The number of development projects seeking Environmental Clearance from the EPA in the Maldives has shown a clear upward trend over the years. While there was a temporary decline in 2020 due to the COVID-19 pandemic and the associated travel restrictions, the years 2021 and 2022 have witnessed a rapid increase in the number of projects (see Figure 78). This upward trend reflects the country's ongoing development trajectory. It therefore becomes imperative to emphasize the importance of the Maldives' environmental and social due diligence processes, regulations, and monitoring. A robust system with stringent monitoring is crucial to ensure that the rapid pace of development does not come at the expense of environmental and social costs. This trend also underscores the significance of comprehensive prior planning, particularly with an environmental lens, at both regional and national levels. By incorporating environmental design and management considerations and promoting public participation, the country can ensure that development projects are sustainable, resilient, and inclusive.

Figure 78. The number of infrastructure development projects in the Maldives seeking environmental clearance is on an upward trend.

Number of Environmental Safeguard Assessments Conducted Per Annum from 2015-2022 in the Maldives for Development Projects (92 percent of which are EIAs; 7 percent EMPs; and 1 percent ESMPs). Projects in Other categories not shown.



Source: World Bank based on EIA reports published by the EPA

By incorporating environmental design and management considerations and promoting public participation, the country can ensure that development projects are sustainable, resilient, and inclusive.

The EPA maintains an online database of disclosed EIAs, which provides insights into the key sectors where development projects are taking place. Most projects fall under the infrastructure category, ranging from generic infrastructure to harbor and shore/coastal protection to land reclamation. Another significant sector for EIAs is environmental service delivery, encompassing areas like water and sewerage management, SWM, and water supply. This focus on specific sectors allows the EPA to ensure that the EIAs conducted for these projects are technically robust, with in-depth analysis of environmental and social impacts. Many of these activities require careful management of environmental and social aspects throughout the project lifecycle, including design, implementation, and compliance monitoring. The EPA issues Terms of Reference (TORs) project-wise, providing specific guidelines and scoping to address operational aspects and ensure proper management of infrastructure

There is currently no clear requirement for regular reporting on the implementation of measures outlined in project-specific plans from the project proponent to the EPA.

and industrial activities. Additionally, there is a growing number of miscellaneous projects, such as aquaculture, industry, and agriculture. These projects often involve operational work and smaller industrial activities that may not always undergo the formal EIA process. Currently, there are no formal mechanisms in the country to issue Environmental Protection Licenses to industry, agriculture and service delivery sectors currently in the Maldives as per the EPPA. Likewise, there are no established compliance and certification systems like Environmental and Social Management Systems (ESMS) based systems.

Photo Description: Fish swimming in Seagrass, Maldives © Benjamin L. Joes/Unsplash

4.4 Barriers to environmental and compliance monitoring

As per the EIA regulation, the Ministry of Environment designates an enforcement officer to monitor environmental impacts of a project. This officer has the authority to enter project sites and inspect the implementation of the project to determine if any violations of the regulation have occurred. However, there is currently no clear requirement for regular reporting on the implementation of measures

Currently, there is no system in place for issuing operational Environmental Licenses or providing operational guidelines for sectors such as fish processing, agriculture, small industries, and service entities like resorts and guest houses.

outlined in EMPs or other project-specific plans from the project proponent to the EPA. As a result, once projects move beyond the preparation stage, there is often a lack of consistent due diligence and reporting on their environmental impacts. Monitoring and managing monitoring data pose significant challenges, primarily due to capacity constraints at the EPA, including financial and technical limitations. The wide geographic spread of subprojects across the Maldives and the high costs associated with travel further exacerbate these challenges. Insufficient human resources within the EPA for conducting monitoring activities is also a limiting factor. The EPA's annual report for 2022 highlights the ongoing challenges related to limited staff and equipment. Addressing these challenges requires exploring alternative approaches to monitoring, including decentralized or outsourced monitoring systems. Embracing technology such as remote sensing and geo-enabled monitoring systems can also offer potential solutions. These approaches could help improve monitoring efficiency, reduce costs, and overcome geographical barriers.

The monitoring of environmental impacts associated with the operations of facilities, both in the service and industrial sectors, is limited after the preparation of EIAs. Although standards exist for the management of environmental parameters, monitoring efforts are constrained by factors such as a lack of laboratory facilities in the Maldives for testing and monitoring, as well as insufficient human and financial capacity to oversee industry and service operations and monitor emissions into air and water. Currently, there is no system in place for issuing operational Environmental Licenses or providing operational guidelines for sectors such as fish processing, agriculture, small industries, and service entities like resorts and guest houses. Strengthening enforcement in these areas would require the establishment of a monitoring and reporting system or a self-reporting and verification system for industries and environmental service sectors.

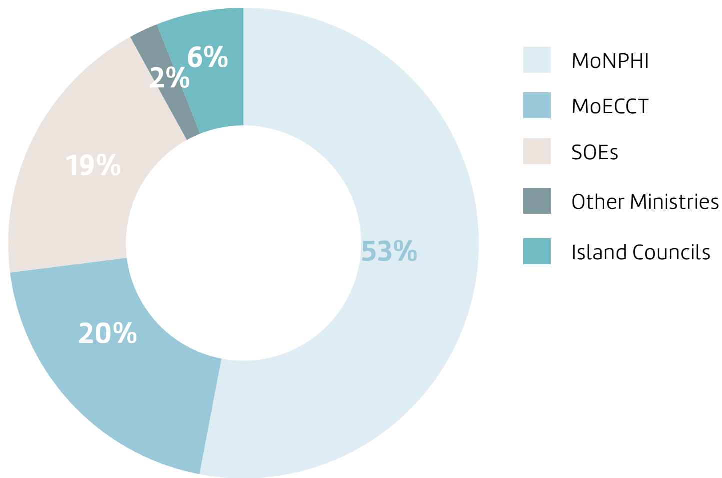
To foster trust in the EPA as an independent regulatory body and enhance its operational efficiency and resource management, it is crucial to establish decision-making processes that are independent and autonomous within the agency.

There is a potential for conflicts of interest in the environmental clearance process for development projects and programs. While the EPPA designates the EPA as the regulatory authority responsible for environmental regulation and clearance of EIAs, the MoCCEE, specifically the Minister, retains the right to overrule and request the Director General of the EPA to issue an EDS to a project proponent, as agreed upon by the Cabinet. An analysis of EIA data from 2015 to 2022 reveals that 56 percent of EIAs have been conducted for projects led by the GoM (see Figure 79), including Ministries, Government Departments, State-Owned Enterprises, and Island Councils, rather than the Private Sector. Within the GoM, the Ministry of National Planning, Housing, and Infrastructure (MoPHI) has requested the majority of EIA clearances, followed by the MoCCEE (See Figure 79 for more details). To foster trust in the EPA as an independent regulatory body and enhance its operational efficiency and resource management, it is crucial to establish decision-making processes that are independent and autonomous within the agency. Implementing such measures not only ensures the integrity of the EPA but also has the potential to attract a greater pool of human resources to support its endeavors.

The key institutions involved in environmental governance face significant challenges due to insufficient human and technical capacity.

Figure 79. There is a potential for conflict of interest in environmental clearances for development projects and programs.

Relative share of EIAs by Project Proponent (2015-2022)



Source: World Bank based on EIA reports published by the EPA

The key institutions involved in environmental governance face significant challenges due to insufficient human and technical capacity. As of 2023, the EPA, which is housed within the MoCCEE, has a staff of only 48[653,654] Of these, 23 staff handle corporate areas, ranging from fiduciary to management of human resources and other such areas. The technical staff strength is only 23 with one contract staff. The current technical staff strength is responsible for covering all technical roles of the EPA, from the appraisal of EIAs to clearance to its actions on oversight and monitoring of Protected Areas.[655] According to the EPA, the management of human resources and the lack of dedicated staff to implement their mandate forward remains their main challenge.[656] They experience shortages in specific technical areas and middle management, and the current wage scales have resulted in high turnover over the past few years. Furthermore, there is no dedicated program for staff development and capacity building, nor a budget allocated to ensure that staff remain updated on key technical areas and can effectively carry out their mandate.[657]

653 MoECCT (2022). Annual Report 2022 – Environmental Protection Agency. https://www.environment.gov.mv/v2/en/download/19834

654 Sri Lanka ES. (n.d.)

655 Personal communication with the EPA (January 2022)

656 Personal communication with the EPA (January 2022)

657 Personal communication with the EPA (January 2022)

SEA is a systematic process for evaluating the environmental implications of a proposed policy, plan, or program and provides means for looking at cumulative effects and appropriately addressing them at the earliest stage of decision making alongside economic and social considerations.

The EPA has identified the need for equipment to support their activities, particularly in compliance and environmental monitoring. While the Maldives Clean Environment Project, supported by the World Bank, has provided a research vessel and equipment for air quality monitoring and waste management training, there are requirements for additional resources such as handheld devices for training purposes and the adoption of remote sensing and geo-enabled monitoring systems. These measures will facilitate the challenging task of monitoring compliance and conducting environmental due diligence across the vast geographical area of the Maldives. Strengthening these aspects is crucial for the EPA to establish an effective environmental governance system and ensure the implementation of the EPPA in the context of the country's rapid development trajectory.

Currently, there is no Strategic Environmental Assessment (SEA) in place. SEA is a systematic process for evaluating the environmental implications of a proposed policy, plan, or program and provides means for looking at cumulative effects and appropriately addressing them at the earliest stage of decision making alongside economic and social considerations.[658] An SEA enables the assessment of how a policy, plan, or program may impact the environment and climate resilience, and provides opportunities to enhance environmental conditions and contribute to climate-resilient and low-carbon development. It is ideal to integrate SEA into the early stages of policy development, with strong government ownership, potentially through agencies responsible for national planning. Public participation is also crucial for the successful implementation of SEA. By providing strategic-level recommendations and controlling interactions and cumulative effects, SEA complements project-level EIAs.

4.5 Recommendations

Short-term recommendations

Explore ways to increase budget and capacity at the EPA. In addition to funding from the central government, explore alternative funding sources such as the "polluter pays" principle, where industries and polluting entities contribute to the EPA's budget through fines and environment licensing fees. Consider utilizing revenue from environmental taxation, like the green tax, to support EPA operations (also see Section 3.2.2). These provisions should be legally defined and implemented to ensure transparency and accountability. This revenue can then be pumped back into monitoring systems.

Establish a nationwide and cost-effective environmental data collection system. Develop a targeted and planned approach for environmental compliance and quality monitoring, focusing on building capacity at the

658 European Union. (2010). Environment, Climate Change and Green Economy. https://capacity4dev.europa.eu/groups/public-environment-climate/info/strategic-environmental-assessment

island level. Implement a decentralized approach to monitoring, leveraging technology for both environmental quality and compliance monitoring. This can include the use of remote sensing, geo-enabled monitoring systems, and data collection tools to streamline data collection and analysis processes.

Strengthen and align the government's commitments by developing and implementing an updated NEAP that integrates environmental considerations into the national development framework. A strengthened NEAP would facilitate better coordination and support the country's existing development and environmentally related strategies and action plans. Regular updates, every 5 years or so, will ensure that actions are implemented consistently and sequentially, avoiding maladaptive development (see also section 2.3.6) and promoting the improvement of natural assets. This will require the involvement of government ministries, institutions at different levels, private sector (especially those in the tourism industry), civil societies, development partners, and local communities.

Evolve a framework for Natural Capital Accounting (NCA) in the Maldives. As an island nation heavily reliant on its environmental assets for tourism, fishing, and livelihoods, the NCA framework helps the Maldives incorporate the value of its assets into national decision-making processes. By integrating the environment into economic decision-making, NCA provides policymakers and other stakeholders with a clearer understanding of the full value of the natural resources they manage and use. The NCA framework mandates the internalization of externalities, ensuring that every societal cost and benefit associated with environmental impacts is duly considered. Furthermore, it can also help unlock opportunities to access carbon financing, highlight areas requiring conservation, and identify potential revenue sources from natural capital.

Strengthen due diligence processes and analytics to enhance their effectiveness in promoting environmentally sensitive development. While the Maldives already has a sound environmental due diligence system aligned with international best practices, there is room for improvement. One approach is to expand the scope of EIA by including a defined area around project boundaries. This will enable a comprehensive evaluation of project implementation beyond immediate boundaries, identifying potential impacts and means of mitigation at the design stage. Updating the standard screening form used by the EPA to include screening criteria on cumulative impacts will further strengthen the analytical process of future EIAs. During scoping meetings, the assessment of EIA TORs against sectoral criteria and the use of sector-focused environmental screening mechanisms for specific projects will ensure that TORs are tailored to each project and include provisions to address cumulative impacts. This will contribute to more robust and impactful due diligence processes, supporting environmentally sensitive development in the Maldives.

Box 23: Towards a Framework for Natural Capital Accounting (NCA) for the Maldives

Natural capital accounting (NCA) refers to the systematic, reliable, and regular measurement of stocks and flows of natural resources and ecosystems so that their state, as well as the benefits they provide to society, can be recognized, understood, and integrated into policy, planning, and decision-making. NCA is, therefore, an organizing framework for environmental information using an accounting approach. The United Nations System of Environmental-Economic Accounting (SEEA) is recognized as comprehensive international standards for NCA. SEEA integrates economic and environmental data to provide a more comprehensive and multipurpose view of the relationships between the economy and the environment and the stocks and changes in stocks of environmental assets as they bring benefits to humanity. Conceptually, the SEEA's approach is reflected in the ecosystem accounting framework (Figure 80). This framework reflects the importance of integrating data on the stocks of natural capital – asset extent and asset condition – and data on the ecosystem services and benefits that are supplied to the economy and society when considering natural capital. For any NCA, it is vital to first collect data on the extent of the assets before considering the asset condition, ecosystem services, and monetary value of the ecosystem services.

The Maldivian government has recently initiated the piloting of the System of Environmental Economic Accounting Ecosystem Accounting (SEEA EA) in Laamu Atoll in southern Maldives. The SEEA EA comprises five core accounts: 1) Ecosystem Extent, which tracks the size and changes in different ecosystem types within set regions; 2) Ecosystem Condition, monitoring the health of ecosystems over time; 3) & 4) Physical and Monetary Ecosystem Services Flow accounts, which document the supply and use of ecosystem services; and 5) Monetary Ecosystem Asset, which notes changes in ecosystem assets, including degradation and enhancement. Implementing NCA in the Maldives requires a comprehensive understanding of its diverse ecosystems, ranging from coral reefs and mangroves to seagrass beds. Chapter 2 of the CEA identifies gaps and outlines recommendations to better understand the evolving dynamics of the Maldives' Blue Natural Capital. The following table provides an overview of the data needed for natural capital accounting in the Maldives. Where possible, it is recommended that NCA be presented in maps in combination with relevant accounts.

The success of the NCA framework in the Maldives relies on comprehensive data, collaboration, and continuous upskilling of involved personnel. This framework demands geographically specific data and an understanding of how ecosystems evolve over time. A consistent mechanism for data collection, analysis, and updates is integral to this framework. As of February 2023, the Maldives faces a significant data gap concerning the extent and health of its natural assets, hindering progress towards monetary NCA and ecosystem service valuation (ESV). The absence of baseline information on reef health and official statistics related to coral, fish, and water quality is alarming, despite data collection initiatives dating back to 1998. Critical needs include expanding long-term plots highlighting reef variability and gaining insights into sedimentation rates. There's also a noticeable data gap regarding reef fisheries, groundwater depletion, visitation metrics in protected zones, waste composition, among other factors. To address these shortcomings effectively, a twofold strategy is proposed. A bottom-up approach advocates for granular field data collection and encourages citizen monitoring. Simultaneously, a top-down methodology promotes the establishment of a nationwide system leveraging satellite and aerial sensors for the surveillance of critical ecosystems. Collaboration is crucial; government departments, research institutions, non-profits, and other stakeholders should be engaged. Setting transparent protocols for data collection and sharing allows for meaningful comparisons, either with other areas or over distinct timeframes. The focus should also be on harmoniously integrating diverse datasets with consistent data standards. Sustained training and capacity building of all stakeholders involved in this process are vital.

Figure 80. The Core Ecosystem Accounting (EA) Framework.

Source: Adapted from SEEA Ecosystem Accounting, UN et al 2021

Table 21. International Treaties which Maldives is a party to

Category	Data
Coral Reefs	- Extent (total coral cover area) by species type - Coral health status (including species diversity) by location - Structural complexity and depth profiles - Carbonate production rates
Coastal Fisheries	- Fish stock by species (and if possible, spatial distribution) - Spawning seasons and sites - Fishing effort, catch data, and bycatch - Habitat quality and availability
Mangroves	- Extent (total cover area) by species type - Mangrove health (including species diversity and canopy density) - Soil characteristics and carbon storage capacity
Seagrass Beds	- Extent (total cover area) by species type - Seagrass health (including species diversity and biomass) - Role in sediment stabilization and carbon sequestration
Seabird	- Species diversity, population sizes, and distribution - Nesting seasons and sites - Feeding habits and migration patterns
Water Quality	- Salinity, temperature, pH, and dissolved oxygen - Nutrient concentrations - Presence of pollutants or toxins
Sea Level Data	- Historical sea level trends - Tidal variations and storm surge data
Oceanographic Data	- Current patterns and strengths - Sea surface temperature anomalies - Upwelling zones and nutrient dynamics
Marine Mammals and Pelagic Species	- Species diversity, population size, and distribution - Migration patterns and breeding sites - Feeding habits and trophic relationships - Pollination rates and relevant species

Category	Data
Beach Dynamics	- Erosion and accretion rates - Sediment size and composition - Dune vegetation and stabilization
Human Activities and Pressures	- Tourism footprints - Fishing efforts and methods - Waste management - Coastal development and land reclamation
Climate Data	- Historical and current climate patterns - Extreme weather events data
Biodiversity	- Endemic and endangered species lists - Interaction webs or trophic dynamics - Invasive species and their impacts
Ecosystem Services	- Pollination rates and relevant species - Recreational and cultural value assessments - Carbon sequestration and storage values for various habitats

Source: Convention websites.

Ensure that adverse environmental impacts of developmental projects in the Maldives are effectively avoided or minimized through the application of the mitigation hierarchy. Currently, the use of the mitigation hierarchy is not practiced in the EIA analysis. To address this, it is necessary to incorporate the mitigation hierarchy into the EIA system by conducting a review and update of the EPPA and making amendments to screening criteria and EIA Terms of References (TORs).[659] The mitigation hierarchy, widely recognized as a global best practice, is incorporated in international standards such as the International Finance Corporation (IFC) Performance Standards (PS). PS 6 on biodiversity conservation and sustainable management are widely regarded as the most rigorous EIA requirements.[660] Mitigation hierarchy provides a framework for addressing environmental impacts through a sequence of measures: avoidance, minimization, remediation, and offsetting. Widely adopted by countries and lending agencies, this framework is instrumental in mitigating negative impacts on biodiversity and ecosystem services. Implementation of the mitigation hierarchy will be crucial for improving coastal infrastructure design (see Section 2.3) and ensuring environmentally sensitive development in the Maldives.[661]

Engage in robust and active monitoring particularly in atolls with a high concentration of development projects. The EPA can utilize environmental

659 IFC. (2012). Performance Standard 6. Biodiversity Conservation and Sustainable Management of Living Natural Resources (2012). https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/performance-standards/ps6.

660 ibid.

661 Phalan, B., Hayes, G., Brooks, S., Marsh, D., Howard, P., Costelloe, B., ... Whitaker, S. (2018). Avoiding impacts on biodiversity through strengthening the first stage of the mitigation hierarchy. Oryx, 52(2), 316-324. doi:10. 1017/S0030605316001034

clearance data to identify specific atolls where their central team of specialists can focus monitoring efforts. These atolls can be prioritized based on the intensity and scale of development activities (see Figure 81 for details on the spatial distribution of EIAs). In contrast, atolls with fewer development projects can serve as pilot areas for decentralized monitoring efforts. This approach can involve trained Island Level Environmental Officers stationed at Island Councils or working in collaboration with local civil society groups. There is potential to forge collaboration with local resort teams as-well. These decentralized teams can actively monitor and assess environmental impacts within their respective areas, ensuring that mitigation measures are implemented effectively. To enhance the effectiveness of the decentralized monitoring framework, it is recommended to deploy digital tools that facilitate data collection and analysis. One such tool is the Geo-Enabled Monitoring System Methodology, which can be utilized in conjunction with platforms like KoboToolbox (an open-source data collection tool) or ArcGIS Survey 123. These tools enable efficient and geographically referenced monitoring, allowing for seamless data integration and analysis within a pre-established data collection

The Maldives urgently needs to implement a comprehensive Marine Spatial Planning (MSP) framework in alignment with the Noo Raajje initiative. This initiative is geared towards safeguarding ocean resources, rejuvenating coral ecosystems, promoting sustainable growth of ocean industries, and ensuring that at least 20% of Maldivian waters are protected. A key part of this effort is to create an MSP based on scientific research and community input. UNESCO-IOC defines MSP as "a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that have been specified through a political process."[662] MSP is inherently a participatory process that regulates human activities in marine and coastal areas to ensure both the vitality of ecosystems and enduring socio-economic benefits. A key aspect of MSP is zoning regulations that help organize the spatial and temporal distribution of various human activities in marine environments. By doing so, MSP aims to minimize potential conflicts between various uses, ensuring that activities like fishing, tourism, and conservation coexist harmoniously and sustainably. Furthermore, MSP also aids in improved Protected Areas Management by ensuring each PA has a strong, actionable management plan and establishing regular monitoring and evaluation systems.

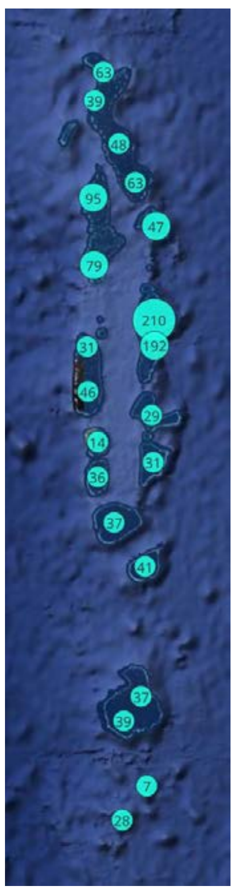
The Maldives has a robust legal foundation for ocean management, and MSP provides a comprehensive approach to address diverse marine challenges and opportunities. The existing legal foundations for ocean management in the Maldives are strong, grounded in the Constitution of 2008 and numerous other laws related to the environment, fisheries, tourism, and public finance. MSP offers a functional framework for policy coherence opening up newer ways of problem solving tackling sustainable resource management, environmental

662 UNESCO-IOC/European Commission. 2021. MSPglobal International Guide on Marine/Maritime Spatial Planning. Paris, UNESCO. (IOC Manuals and Guides no 89)

protection, economic diversification, and climate change adaptation. It is inherently cross-sectoral, requiring the involvement of various governmental departments like fisheries, tourism, and environment. To be effective, MSP should harness the most up-to-date data on marine ecology and coastal development. It should be comprehensive, encompassing activities ranging from fishing and shipping to renewable energy, aquaculture, and infrastructure projects. Moreover, it's crucial for MSP to align with other strategic frameworks, such as the Strategic Environmental Assessment (SEA) and the Fifth Tourism Master Plan. By focusing on the collective impact of various activities, MSP offers a more integrative perspective than viewing each activity in isolation. With consistent updates based on fresh research and data, MSP can prevent fragmented development and lay the foundation for a resilient Blue Economy.[663]

Figure 81. About one-third of EIAs are conducted in the Kaafu atoll, with the remaining two-thirds spread out across the archipelago

Number of EIAs for Development Projects between 2015 and February 2023, by atoll



Source: World Bank based on EPA EIA Online Repository.

663 UNESCO-IOC/European Commission. 2021. MSPglobal International Guide on Marine/Maritime Spatial Planning. Paris, UNESCO. (IOC Manuals and Guides no 89)

Box 24.Examples of SEAs in other countries

An SEA for the National Climate Change Strategy (NCCS) of Montenegro was led by the Ministry of Environment and Tourism, with support from the EU, linked to the Government's own planning process. This allowed more effective uptake of the SEA recommendations by the Government to influence their own planning process. The SEA was prepared in response to the requirements of Montenegro's SEA Law (2005). The Study looked at all aspects of NCCS and was able to provide recommendations to contribute to the re reforms in the area of environment and climate change in Montenegro in order to comply with obligations from the climate change acquis ensuring the continuity of a recently initiated assistance provided to the beneficiaries in the Sector. It also facilitated the avoidance of delays in implementation of already planned support via the NCCS to beneficiaries while ensuring the environmental effects of proposed strategic actions are assessed and mitigated and best practicable environmental options are explored. It also provided Early warning of cumulative effects and large-scale changes. The main objective of the SEA was to enhance the environmental performance of the NCCS.

The SEA for Rwanda's agriculture sector was crafted during the revision of the Government's agriculture strategy, with the Ministry of Agriculture playing a pivotal role in coordinating the SEA. Executed in 2012 by the EU Delegation to Rwanda, the Government of Rwanda (via its Ministry of Agriculture and Animal Resources - MINAGRI), and other donors, the SEA aligned with the formulation of Rwanda's Strategic Program for the Transformation of Agriculture III (SPTA3) for 2013-2018. The overarching goal of the SEA was to seamlessly integrate environmental considerations into the agriculture sector and the rural feeder roads sub-sector. Rwanda's SEA unfolded in two main phases: a scoping study and an SEA study. The scoping study identified critical environment and climate change issues in agriculture, considering the impacts of degraded natural resources and climate change on sector performance. Key issues were validated in a stakeholders' workshop. The SEA study delved into these issues, proposing options and opportunities. Recommendations emerging from Rwanda's agriculture sector SEA aimed at enhancing the environmental sustainability of SPTA-3. Key recommendations included prioritizing soil and water conservation, objective monitoring of soil erosion with consistent reporting, optimizing input use for increased yields instead of relying solely on inorganic fertilizers, and incorporating flexibility into the Crop Intensification Program for improved environmental performance and climate resilience. Moreover, the SEA significantly influenced the design of a €200 million sector reform contract and served as a reference for central and district spending on feeder roads. Some recommendations extended beyond core agricultural sector institutions, suggesting improvements handled by Environment and Natural Resources authorities, such as strengthening the EIA system and enhancing environmental enforcement capacities.

Source: European Union, Capacity4Dev Portal.

Medium- to long-term recommendations

Develop a robust Strategic Environmental Assessment (SEA) process to ensure Environmental, Social and Climate Change related impacts are systematically considered from the policy and planning stage. This proactive approach will help strengthen the countries' environmental governance processes and contribute to more integrated planning (see Section 2.3.6). There is no single approach to SEA, which can take different forms according to the specific needs. The implementation of SEA should be integrated into the government's planning process, allowing for maximum influence and effectiveness. Considering the existing National Spatial Plan, Noo Raaje Program, Tourism Development Master Planning Process, and Strategic Action planning, incorporating SEA as a tool will provide significant benefits in achieving sustainable development, environmental protection, and climate change goals in the Maldives.

Promote better public participation in the EIA process throughout the process to ensure a transparent and fair environmental governance system. Public involvement should be integrated into all phases of project or program cycles to ensure a fair and transparent decision-making process. This inclusive approach enables the inclusion of perspectives from affected and interested stakeholders, leading to more informed choices and better environmental outcomes.[664] One example of effective public participation can be observed in Sri Lanka, where the National Environmental Act allows for public inspection and comment on EIA reports during a mandatory 30-day period. The reports are made available in the country's three working languages, facilitating access and engagement for a diverse range of stakeholders. Timely and well-planned public involvement can contribute significantly to EIA studies and the successful design, implementation, and operation of projects and programs. It enables a better understanding of the specific content at the atoll and island level, the collection of indigenous knowledge and experiences on key impacts and mitigation measures, and the identification of alternatives. Public consultations, as opposed to mere solicitation of comments, are often more effective in fostering meaningful engagement. While the EPPA includes provisions for consultations, it is crucial to make these consultations an explicit requirement in the EIA Terms of Reference for project proponents and operators. This ensures consistent and meaningful public involvement throughout the project's lifetime. At the very least, public involvement should provide opportunities for those directly affected by a proposed project or program to express their views regarding its environmental and social impacts.[665] The use of internet-based consultation tools will assist the EPA and MoCCEE in facilitating a full-bodied consultation process throughout project implementation and operation. The EPPA should incorporate specific provisions that outline the need for and process of consultations through the EIA process, further strengthening the public participation framework.

Enhance sector-specific lenses in environmental and social due diligence processes. With substantial growth in infrastructure and service sectors, it's crucial to customize due diligence approaches for early and consistent identification and mitigation of potential impacts throughout the project lifecycle. Prioritize compliance monitoring, focusing on adherence to environmental standards, especially concerning liquid, solid, and air emissions during facility operations. To achieve this, the EPA should craft and implement sector-specific EIA TORs. Concurrently, the establishment of sectoral guidelines, standards, and monitoring protocols will aid the EPA in effectively managing the due diligence process and governance structure for these projects. These guidelines and codes of practice should encompass pollution control, environmental impacts from operations, social considerations, and overall Environmental Health and Safety. By institutionalizing these guidelines and codes of practice, the EPA can ensure that environmental management extends beyond the EIA period, addressing long-term sustainability. The development of a

664 International Association for Impact Assessment. (2013). Southeastern Europe. https://www.iaia.org/pdf/south-eastern-europe/Sec_E_Topic_3.pdf

665 ibid.

Sectoral Environmental Guidelines series will play a pivotal role in promoting environmental compliance. These guidelines will offer essential information for assessing potential impacts, facilitating the design of appropriate mitigation and monitoring measures.[666] Neglecting aspects of Environmental Health and Safety, as observed in some countries in South Asia, can lead to difficulties in management and control over time. Therefore, an Environmental Licensing System can be implemented for industries, service operators, and resorts. This system will enforce compliance with environmental standards, encourage pollution prevention, waste minimization, and cleaner production, while promoting environmentally sustainable planning and development. [667] Furthermore, the licensing system can generate revenue for the EPA through fees and renewals based on performance.

Build capacity for environmental monitoring on the ground. Members of the EPA have already received training via the World Bank's Environmental and Social Framework's Country Capacity Building Initiatives on the Use of KoboToolbox. This tool has proven effective in collaboration with the Maldives Clean Environment Project for the development of operational environmental management plans. Furthermore, by implementing a licensing system with a predetermined fee structure, it becomes possible to allocate funds specifically for ground-level monitoring and introduce self-reporting mechanisms. For instance, following the ISO 14000 series on environmental certification, certificate holders can engage in self-evaluation of their environmental management systems through internal audits and self-assessments.[668] Streamlining this process is facilitated by digital tools like the ISO 14001 internal audit checklist, which assists in documenting and tracking process improvements.

Strengthen the independent mandate of the EPA with more autonomous decision making and operative authority as a regulator will ensure further that such potential for conflict of interest is reduced and that independent decision making can be further mandated to the EPA as an entity via the EPPA. In countries such as the United States and Singapore, environmental regulatory agencies having a standalone mandate has helped these countries achieve a stringent environmental governance system, one which also ensures that environmental due diligence processes are accountable. This has also helped agencies such as the US EPA and Singapore's National Environmental Agency (NEA) become globally recognized agencies that produce internationally recognized standards and best practices. For instance, the US EPA has its own Strategic Plan which identifies the measurable environmental and human health outcomes the public can expect from EPA and describes how they as an independent agency achieve these results. While these agencies are within

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666 U. S. Agency for International Development. (n.d.). Sector Environmental Guidelines & Resources | Sectoral Environmental and Social Best Practices. https://www.usaid.gov/environmental-procedures/sectoral-environmental-social-best-practices/sector-environmental-guidelines-resources

667 Government Information Center of Sri Lanka. (n.d.). GRANT APPROVAL TO TRANSFER RAW MATERIALS OR ACCESSORIE.S https://gic.gov. lk/gic/index. php/en/component/info/?id=622&catid=70&task=info

668 ISO. (n.d.). ISO 14001 and related standards - Environmental management. https://www.iso.org/iso-14001-environmental-management.html

Ministries their mandates are defined as autonomous and independent which lessen the potential for conflict of interest, especially when implementing regulations and monitoring compliance of government run and government owned projects and operations such as those of SOEs.

Consider designing an incentive structure and career progressions to attract and retain technical staff. Another option would be to work with local universities on programs where, for instance, graduates with environmental degrees can be hired directly in the Government via paid intern and development programs. Like the private sector, the public sector also needs to start thinking about "employee value proposition"(EVP)– what the EPA offers to employees for their time, effort, experience, and ideas needs to also translate to what they get in return.[669] These include tangible rewards, the experience of working in the public sector, the way its leadership helps employees, and the substance of the work. In terms of substance, the EPA offers many technical areas of opportunity for growth but this needs to be coupled with an overall strengthening of the institution as a whole to be seen as a strong and well-resourced agency to carry out its mandate to then in turn attract a stronger workforce and retain it.

669 Hays Talent Solutions. (n.d.). The importance of EVP and the next generation of employees. https://www.haystalentsolutions.com/-/the-importance-of-evp-and-the-new-generation-of-employees

05

Nature and Climate Financing

5.1 The climate and nature financing gap of the Maldives

The Maldives urgently needs to establish a comprehensive financing plan to implement its climate adaptation strategy, taking into account the country's high debt situation. While the country's NDC sets out its climate change mitigation and adaptation goals, there's a distinct absence of detailed implementation strategies and cost estimates. This shortcoming is especially problematic given the high cost associated with achieving climate change adaptation goals compared to the mitigation goals. The Maldives contributes a mere 0.003 percent to global greenhouse gas emissions, implying modest financing requirements for mitigation. Conversely, the country's climate adaptation needs, both pressing and expensive, highlight the urgency for a comprehensive financing strategy.[670] The Maldives' nature-related plans are well articulated in the National Biodiversity Strategies and Action Plan (NBSAP) II: 2016-2025. Financing needs for the goals in this plan are around 64 percent of the 2022 government revenue. Hence, the Maldives' climate adaptation needs are not only the most pressing, but they are also costly by comparison, and a comprehensive financing plan is of paramount importance.

Coastal protection is a critical concern for the Maldives, with the cost of adaptation measures contingent on the chosen coastal protection strategy. Several documents, including the Report of the Survey of Climate Change Adaptation Measures in Maldives (Ministry of Environment and Energy, 2015), provide a potential cost spectrum for these strategies. Both the GoM in its Second Communication to the UNFCCC and in its Technical Assessment of Climate Finance for Island States in the Indian Ocean refer to this range.

670 MoECCT (2020). Update of Nationally Determined Contribution of Maldives. https://unfccc. int/sites/default/files/NDC/2022-06/Maldives%20Nationally%20Determined%20Contribution%202020. pdf

According to a 2011 study, the least costly engineering solution for protecting the coastline of settlements (jumbo bags) has an estimated total cost of US$ 252 million, while the most expensive solution (concrete tetrapods like shown in Figure 82) is expected to cost around US$ 7.1 billion. However, the actual cost should be calculated considering the current level of protection provided by existing coastal defenses, the additional protection needed along each island's coastline, and which engineering solutions are best suited to bridge this gap, both technically and economically. Consequently, the optimal coastal protection strategy may vary between islands and even between different segments of the same island's coastline.[671]

The Maldives' Nationally Determined Contribution does not provide detailed estimates of the country's climate financing needs. Nevertheless, several documents provide rough estimates for certain aspects. Specifically, in a 2022 Technical Assessment of Climate Finance for Island States in the Indian Ocean, the UNFCCC posits that the estimated costs for the Maldives to meet its updated mitigation goals should total approximately US$ 1 billion.[672,673] In addition, it cites an estimate of US$ 64 million for adaptation necessities concerning water security, based on direct communication with the Maldivian Ministry of National Planning, Housing, and Infrastructure, as well as the Ministry of Environment, Climate Change, and Technology.[674]

Figure 82. Tetrapods are the most costly coastal protection solution

Tetrapods on the coast of Male.

Source: Flickr/Mark Fischer

671 Ministry of Environment and Energy. (2016). "Second National Communication of Maldives to the United Nations Framework Convention on Climate Change''. https://unfccc. int/sites/default/files/resource/SNC%20PDF_Resubmission.pdf

672 UNFCCC. (2022). "Technical Assessment of Climate Finance for Island States in the Indian Ocean Annex to the Island States in the Indian Ocean Climate Finance Access and Mobilization Strategy". https://unfccc.int/documents/470329

673 All USD amounts in Chapter 7 are in 2022 dollars.

674 ibid.

The range of cost estimates for protecting the full coastline of inhabited islands in the Maldives is strikingly wide, with estimated adaptation expenses hovering from around US$ 0.7 billion to a staggering US$ 11.4 billion.

The range of cost estimates for protecting the full coastline of inhabited islands in the Maldives is strikingly wide, with estimated adaptation expenses hovering from around US$ 0.7 billion to a staggering US$ 11.4 billion. It appears that this cost spectrum doesn't take into account coastal protection approaches that would cost less than US$ 700 million (adjusted to 2022 values). Moreover, the UNFCCC documentation, grounded in a 2011 study, doesn't account for the narrower cost bracket offered by the Maldivian government, which focuses solely on the protection of inhabited areas. This suggests an implied need for prioritizing the comprehensive protection of inhabited islands and questions the effectiveness of less costly solutions in the eyes of the GoM.

When comparing the cost-effectiveness of coastal protection solutions, it is important to consider the total cost over the designed lifetime. The Maldives could seek to finance cheaper options, but such installments are likely to require frequent maintenance, incurring higher costs over time (see Figure 83). For instance, tetrapods present a large one-time expense, but they do not require ongoing maintenance, contrasting with other solutions like cement bags. These latter options, while having lower upfront costs, necessitate significant lifecycle expenses for maintenance. The level of coastal protection provided can also vary among these solutions, contingent upon factors like hydrodynamic conditions and the quality of the design and construction.[675]

A potentially more cost-effective strategy could involve leveraging soft engineering solutions, including NbS like seagrass or mangrove afforestation, beach replenishment, or the rejuvenation of coastal vegetation.

A potentially more cost-effective strategy could involve leveraging soft engineering solutions, including NbS like seagrass or mangrove afforestation, beach replenishment, or the rejuvenation of coastal vegetation. Despite some local doubts about the effectiveness of these softer adaptation measures, their ongoing costs are generally significantly lower than those of gray solutions (as depicted in Figure 83). Global systematic reviews on NbS so far overwhelmingly make the case for them from a cost effectiveness perspective.[676] The experience with the 2004 tsunami event on Sh. Funadhoo, for example, highlighted the efficacy of tidal wetlands in mitigating coastal damage. It's crucial, however, to acknowledge that no comprehensive cost analysis has been conducted yet for expanding seagrass beds, mangrove swamps, and other tidal marshlands. Given their significant potential contribution to any blue carbon program, it is important to explore their practicality and cost considerations as coastal adaptation measures. Other soft engineering measures, such as reviving coastal vegetation that inhibits flooding, remain feasible options. The determination of whether these measures can serve as replacements or merely supplements to concrete breakwaters, and the precise locations for their deployment, warrants separate, updated analysis.

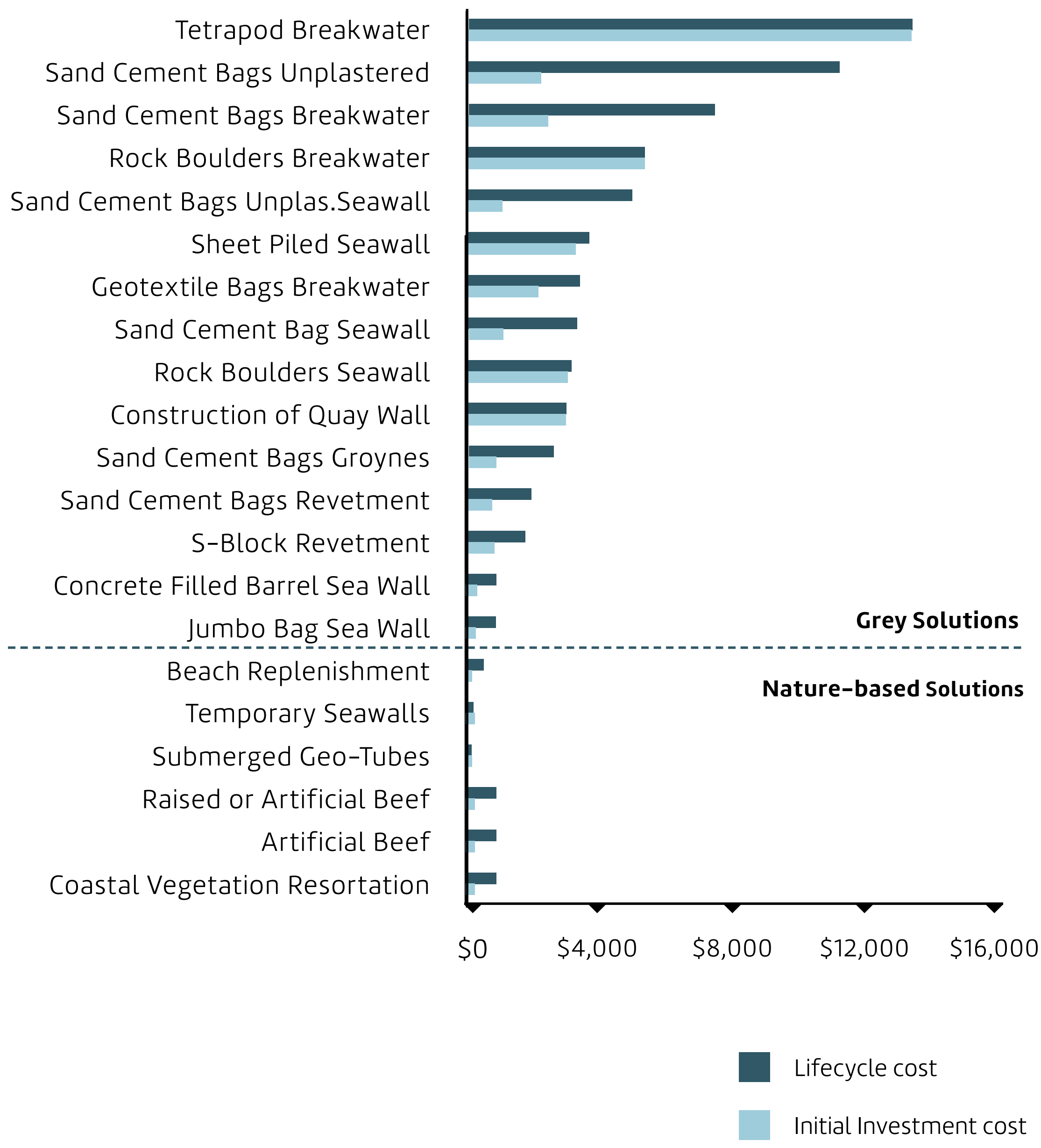
While seagrass beds, mangrove swamps, and other tidal marshes play a vital role in blue carbon programs, detailed cost analysis for their expansion is lacking. It's crucial to study site-specific feasibility and the financial requirements for

675 ibid.

676 Narayan, S., Beck, M. W., Reguero, B. G., Losada, I. J., Van Wesenbeeck, B., Pontee, N., ... & Burks-Copes, K. A. (2016). The effectiveness, costs and coastal protection benefits of natural and nature-based defences. PloS one, 11(5), e0154735.

Figure 83. Nature-based solutions are a more cost-effective coastal protection strategy than grey solutions

Initial investment cost and lifecycle cost (over a 20-year period) of gray solutions and nature-based solutions, in 2022 US dollars per linear meter.



Source: Survey of Climate Change Adaptation Measures in Maldives (administered by the Ministry of Environment and Energy (2015)), adapted by Potomac Group.
Note: *The degree of coastal protection may vary between measures. Costs may have evolved since the first publication of these cost estimates in 2011, and actual costs may vary.*

While seagrass beds, mangrove swamps, and other tidal marshes play a vital role in blue carbon programs, detailed cost analysis for their expansion is lacking.

nature-based coastal adaptation measures. Other soft engineering approaches, like restoring flood-resistant coastal vegetation, also hold promise. However, a comprehensive and updated analysis is needed to determine whether these methods can replace or merely supplement hard engineering solutions like concrete breakwaters. This analysis should also guide the optimal deployment of each method across different areas.

The right choice for Maldives should be selected with care and in consultation with qualified experts and local communities. There isn't a one-size-fits-all solution- each segment of coastline may require a different approach, tailored to its unique needs and circumstances. In some cases, a combination of interventions or so-called "hybrid" approaches such as NbS combined with seawalls and breakwaters, could be necessary. An updated analysis must weigh the full costs and benefits of both hard and soft engineering solutions, and the varying degrees of protection they provide. For instance, while safeguarding only the populated areas on islands could reduce costs to around US$ 7.1 billion, it may leave the natural coastlines in rural areas exposed. Hence, it's crucial to evaluate soft engineering solutions, as outlined in the 2011 report, alongside hard engineering measures. Through careful planning, pilot-testing, and adaptive management, a harmonized approach can be developed that builds on the strengths of both NBS and 'gray' infrastructure.

Maldives' total financing requirements for climate and nature stand could be as high as US$ 12.462 billion through 2030 (see Table 22). A significant proportion of these financial requirements originates from the necessity for coastal protection, which alone could need as much as US$ 11.4 billion. On the other hand, costs associated with biodiversity conservation in the Maldives, as evaluated in the country's NBSAP II document, are substantially lower, approximately US$ 22 million. The remaining financial requirements are allocated towards climate mitigation (US$ 1 billion) and water security (US$ 64 million).

Table 22. Upper-bound total climate and nature financing needs (USD millions)

Mitigation	Adaptation (Water Security)	Adaptation (Coastal Protection)	Biodiversity	Total
1,001	64	11,375	22	12,462

Source: Maldives Original and Updated NDC Documents, UNFCCC, Maldives Ministry of Environment

5.2 Currently available funds

The Maldives continues to struggle to find additional fiscal space to internally lift the burden of climate and nature financing needs. Despite higher tax

The Maldives continues to struggle to find additional fiscal space to internally lift the burden of climate and nature financing needs. Despite higher tax collection and revenues, overall fiscal performance is being constrained by the sharp rise in capital spending and subsidies.

collection and revenues, overall fiscal performance is being constrained by the sharp rise in capital spending and subsidies. Total revenue growth was 18 percent between January-April 2023 compared to the same period in 2022. Much of this came from the Tourism Goods and Services Tax (TGST) and business and property tax collections. However, total expenditure grew by 33.5 percent over the same period as previously planned and budgeted subsidy reforms (including fuel subsidies) that aimed to reduce expenditures by 3 percent of GDP have not been implemented so far. This sharp increase has also been driven by high recurrent and Aasandha (health) spending, increase in the wage bill due to implementation of the Public Sector Pay Harmonization policy in the health sector, higher interest costs, and sustained high levels of capital spending (under the Public Sector Investment Program (PSIP) despite an expected reduction in the budgeted figures. In the first four months of 2023, other recurrent and capital spending climbed by 45.1 and 43 percent (y-o-y), respectively. On the other hand, the blanket subsidy bill continued to rise due to high global commodity prices. The government's spending subsidies reached its historic high as of August 2023, climbing to MVR2.63 billion (US$170.9 million), exceeding the MVR2.28 billion (US$148 million) that was budgeted. Interest payments remained high as of August 2023, reaching MVR2.5 billion (US$162.3 million) compared to MVR2.18 billion (US$141.6 million) during the same period in 2022, also far exceeding the annual average between 2014-2019 of MVR 1.3 billion (US$85 million) or about 2 percent of GDP. This was driven by a large increase in interest payments to both domestic and external debt– due to increased outstanding Treasury securities, and external commercial debt. Rising debt services, including increasing principal payments, is likely to further constrain fiscal space and the balance of payments in the medium term.

The surge in global commodity prices following Russia's invasion of Ukraine put pressure on domestic inflation, the government's fiscal position (from related blanket subsidies on energy, food and other items...

The GoM continues to operate under a substantial deficit which is increasingly financed by the Maldives Monetary Authority (MMA), intensifying the exposure of the financial sector to sovereign bond holdings and contributing to the fragile state of its sovereign debt. The surge in global commodity prices following Russia's invasion of Ukraine put pressure on domestic inflation, the government's fiscal position (from related blanket subsidies on energy, food and other items, as well as government support to state-owned enterprises (SOEs)) and the balance of payments. Large-scale Public Sector Investment Program (PSIP) projects financed by external loans (including commercial and non-concessional loans) and elevated spending on subsidies have kept public debt high in 2022. Total public and publicly guaranteed (PPG) debt rose to US$7.0 billion (112.1 percent of GDP) at the end of 2022 compared to US$5.9 billion (109.1 percent of GDP) a year ago. Domestic debt accounted for 61 percent of GDP, while external and externally guaranteed debt accounted for the remainder (51 percent of GDP). However, these figures do not include advances from MMA. Moreover, fiscal risks – mostly stemming from guaranteed and on-lent loans, as well as trade payables, subsidies, and capital injections to SOEs – were estimated at about US$2.5 billion or 45 percent of GDP in 2019. Therefore, Maldives' fiscal space is limited to absorb

External debt and fiscal vulnerabilities remain a significant concern for Maldives in the medium term.

future shocks to public finances.[677]

The International Monetary Fund (IMF) deemed the Maldives to be at a high risk of debt distress in its 2019 Article IV consultation, aligning with the most recent World Bank/IMF debt sustainability analysis, which identified the existing expenditure policy and resulting fiscal deficit as significant financial hazards.[678] Therefore, fiscal consolidation, through increased revenue mobilization and more targeted and balanced expenditure programs, remains a high priority not only to make fiscal space for climate- and nature-related initiatives, but also in large to maintain the country's capacity to absorb future shocks to public finances and balance of payments.

In order to protect its natural capital and mitigate the impact of climate change, Maldives primarily needs to explore new non-concessional financing options, taking into account the financing capabilities with a long-term planning on public investment management

External debt and fiscal vulnerabilities remain a significant concern for Maldives in the medium term. The country is projected to pay, on average, about US$570 million annually as external debt servicing over the 2024-25 period. Public and publicly guaranteed external debt servicing is then expected to reach US$1.07 billion in 2026, which includes bullet payments for the US$500 million Sukuk – the Islamic bond – and US$100 million private placement – significantly testing the country's ability to repay or roll over this debt. Such high levels of public debt, and associated refinancing risks, make the Maldivian economy extremely vulnerable to domestic and external shocks. Further mobilization of additional debt at non-concessional terms would further deteriorate these vulnerabilities. Thus, despite robust growth prospects, prudent debt management remains a top priority for improving fiscal sustainability, lowering the cost of growth-enhancing investments – especially with large debt service obligations coming due – and ensuring a more resilient economy going forward. In order to protect its natural capital and mitigate the impact of climate change, Maldives primarily needs to explore new non-concessional financing options, taking into account the financing capabilities with a long-term planning on public investment management.

Since 2015, when the Paris Agreement was first drafted, the Maldives has successfully attracted climate and nature-related financing from several sources. The Maldives received over US$ 325 million in grant financing. US$ 85 thousand of this constitutes private sector grants, facilitated through the UBS Optimus Foundation and the David and Lucile Packard Foundation. Additionally, nearly US$ 189 million was raised for climate and nature projects through external debt-based development financing. Most of that amount was loaned on a concessional basis, with just a few project-based loans being non-concessional. This amounts to a total of around US$ 515 million allocated to the Maldives from external sources since 2015. In addition to these sources, the Maldives has a domestic Green Tax which has generated around US$ 336.6 million in revenue since its initiation in 2015. This accounts for almost

677 World Bank. (2023). Maldives Development Update. https://openknowledge.worldbank.org/handle/10986/39627

678 World Bank & IMF. (2020). MALDIVES: Joint World Bank-IMF Debt Sustainability Analysis. https://documents1. worldbank.org/curated/en/293831592861168276/pdf/Maldives-Joint-World-Bank-IMF-Debt-Sustainability-Analysis. pdf

...the financing gap for climate and nature-related initiatives could reach as high as US$ 10.8 billion by 2030.

40% of the country's climate and nature-based financing until 2022. Despite a significant drop in 2020 due to a reduction in international tourism caused by the pandemic, it is expected that the Green Tax revenue will continue to provide a consistent source of income over the forthcoming years. Based on IMF projections, tourist nights spent in the Maldives can increase by more than 50 percent between 2022 and 2027, [679] meaning the Green Tax could generate around US$ 770 million in revenue by 2030.

By combining the revenue from the Green Tax collected thus far with the total external climate and nature-based development financing (including approximately US$ 75 million from unspecified concessional bilateral project-based development financing), we estimate the potential total financing available from 2015 to 2030 to be approximately US$ 1.6 billion. This calculation excludes any potential grant or debt-based financing received after 2022 (see Table 23). Consequently, the financing gap for climate and nature-related initiatives could reach as high as US$ 10.8 billion by 2030. Estimating the upper limit of the required financing for Maldives' climate and nature adaptation efforts is relatively straightforward with the available data. However, determining the minimum financing needs is significantly more challenging due to several factors. Firstly, the majority of the financing needs are for implementing coastal adaptation measures. The lower estimates provided by the government do not consider the potential of nature-based solutions, which may offer more cost-effective alternatives for certain stretches of coastline. Secondly, even if cost estimates were available for nature-based solutions, it is unlikely that these could be effectively applied to the entire coastline, making any lower-bound estimate, even considering existing hard and soft engineering solutions, potentially unrealistic. Thirdly, the original costing analysis requires updating to reflect fluctuations in material prices, given that the cost estimates were made in 2011. Lastly, the cost analysis for Maldives' other climate commitments remains incomplete. Although the UNFCCC provides an overall estimate for the country's mitigation needs, it relies on the government's NDC documents, which lack a thorough costing analysis.

Table 23.Total external financing for climate and nature allocated since 2015 (USD millions)

Grants	Concessional Debt	Non-concessional (or unspecified) debt	Green Tax	Estimated Future Green Tax Revenue	Total
324.50	114.06	74.81	336.62	770.01	1,621.90

Source: OECD, MIRA, IMF, and author compilation and calculation of data. Note 1: "Green Tax" considers cumulative revenue since 2015. Note 2: Includes undisbursed project financing of about USD 30 million

679 IMF. (2022). IMF Executive Board Concludes 2022 Article IV Consultation with Maldives. https://www.imf.org/en/News/Articles/2022/12/20/pr22449-imf-executive-board-concludes-2022-article-iv-consultation-with-maldives

The government has introduced various revenue reforms and expenditure consolidation measures, including new revenue initiatives such as a plastic bag tax under the Waste Management Bill, land sales, land leases for tourism, and real estate tourism

5.3 Exploring climate and nature financing sources

5.3.1 Fiscal vulnerabilities and constraints to financing

Domestically, Maldives' ongoing fiscal consolidation efforts offer an opportunity to align its climate and nature financing needs with its substantial debt burden. The government has introduced various revenue reforms and expenditure consolidation measures, including new revenue initiatives such as a plastic bag tax under the Waste Management Bill, land sales, land leases for tourism, and real estate tourism. Additionally, the government has implemented increases in its Goods and Service Tax (GST) rates. Specifically, the General Goods and Service Tax (GGST), contributing to approximately 14.5 percent of total government revenue, was raised from 6 percent to 8 percent in 2023.[680] The increase in the Tourism Goods and Services Tax (TGST) from 12 percent to 16 percent is expected to bring a more significant impact. In 2022, the TGST represented 30 percent of total government revenue, generating approximately US$ 430.5 million.[681] Unlike the GGST, the TGST is primarily collected in USD, making it an ideal tool not only for financing development projects but also for servicing external debt. With both GSTs experiencing a substantial increase in 2023, the government anticipates higher revenue from these sources, particularly with the projected continuous growth in tourism arrivals and bed nights in the coming years. It's worth noting, however, that the primary focus of these tax hikes is to balance the budget rather than finance additional spending. To mitigate adverse impacts on the country's fiscal situation, new policy initiatives have been implemented to further consolidate government spending. These measures include bulk procurement agreements for pharmaceutical products to reduce the price of medical consumables, more efficient expenditures on the Aasandha Health Insurance Scheme, and a shift towards more targeted direct subsidy regimes. The government aims to reduce the overall budget deficit by 3 percent of GDP through these policy measures.[682]

Continued expenditure reforms aimed at significantly reducing and enhancing the effectiveness of government spending, coupled with more efficient revenue mobilization, are crucial for the debt and fiscal sustainability of Maldives.

Continued expenditure reforms aimed at significantly reducing and enhancing the effectiveness of government spending, coupled with more efficient revenue mobilization, are crucial for the debt and fiscal sustainability of Maldives. Key reform areas, essential for lowering the high levels of public expenditure, replenishing fiscal buffers against future shocks, and reducing the cost of growth-enhancing investments, include ongoing reforms to the Aasandha Health Insurance Scheme, the reduction and rationalization of subsidies to SOEs – particularly for fuel and food subsidies, and the implementation of a robust public investment management framework. Conversely, revenue mobilization can be further improved by diversifying the tax base, mobilizing more domestic sources of revenue, reducing informality, and enhancing the tax morale and equity of the tax system.

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680 MIRA. (2023). "Monthly Revenue Reports". https://www.mira.gov.mv/Publications.aspx#tabs1-2022

681 ibid.

682 Maldives Ministry of Finance (2023). Budget Booklet 2023. https://www.finance.gov.mv/publications/reports-and-analyses/budget-in-statistics

Table 24. Summary of recommended environmental fiscal reforms.

Fiscal policy	Recommended reforms
Floor prices for fish	Eliminating price controls, specifically minimum prices on fish, would reduce potential overfishing (and reduce potential long-term net economic losses from lowered fish stock) and allow for redirection of government budget to investments in fisheries value chain development. Abandoning minimum fish prices should only be considered in combination with measures that mitigate distributional impacts.
Green Tax and Green Fund	Increasing the Green Tax to better reflect the environmental cost of tourists, and allocating a higher share of the Green Fund to conservation efforts would improve offsets to environmental damage from tourism which in turn would promote sustainable tourism in the long-term
User fees, fines, and environment licensing fees	Optimizing structures for user fees, fines, and licensing fees could mobilize the necessary resources for improving the country's waste and pollution management infrastructure
Fuel subsidies	Removing fossil fuel subsidies, particularly on fishing vessels, may reduce inefficient operating practices that contribute to overfishing and the depletion of oceanic fish stocks. Rationalizing fuel subsidies to better instill necessary behavioral responses required to manage consumption during price hikes would significantly reduce expenditures.
Blanket subsidies	Converting blanket subsidies, especially on food, fuel, and electricity, to more targeted forms of social protection can significantly reduce government spending and free up fiscal space for crucial development initiatives, including climate and nature-related efforts
Floor prices for fish	Eliminating price controls, specifically minimum prices on fish, would reduce potential overfishing (and reduce potential long-term net economic losses from lowered fish stock) and allow for redirection of government budget to investments in fisheries value chain development. Abandoning minimum fish prices should only be considered in combination with measures that mitigate distributional impacts.
Green Tax and Green Fund	Increasing the Green Tax to better reflect the environmental cost of tourists, and allocating a higher share of the Green Fund to conservation efforts would improve offsets to environmental damage from tourism which in turn would promote sustainable tourism in the long-term
User fees, fines, and environment licensing fees	Optimizing structures for user fees, fines, and licensing fees could mobilize the necessary resources for improving the country's waste and pollution management infrastructure
Fuel subsidies	Removing fossil fuel subsidies, particularly on fishing vessels, may reduce inefficient operating practices that contribute to overfishing and the depletion of oceanic fish stocks. Rationalizing fuel subsidies to better instill necessary behavioral responses required to manage consumption during price hikes would significantly reduce expenditures.
Blanket subsidies	Converting blanket subsidies, especially on food, fuel, and electricity, to more targeted forms of social protection can significantly reduce government spending and free up fiscal space for crucial development initiatives, including climate and nature-related efforts

If additional strategies are implemented to alleviate the burden of debt service, a portion of new revenue could potentially be directed towards climate and nature projects.

Further steps should be taken for fiscal consolidation, specifically through environmental fiscal policy reforms, to bolster the country's resilience against environmental and economic shocks and explore opportunities for domestically financing nature and climate adaptation needs (see Table 24 for a list of fiscal reforms). If additional strategies are implemented to alleviate the burden of debt service, a portion of new revenue could potentially be directed towards climate and nature projects. Reforming blanket subsidies and subsidies to SOEs to be more targeted and efficient may free up resources that can then be redirected toward climate and nature initiatives. Several environmental fiscal policy reforms should be considered, including the removal of fossil fuel subsidies for fishing vessels, reassessment of the need and impact of floor fish prices (see Section 2.2.4), adjustment of the Green Tax to more accurately reflect environmental damages from tourism,

Fiscal reforms should carefully consider potential impacts on different social groups, and in relevant cases, compensation to vulnerable and low-income households should be contemplated...

and allocating a higher share of the Green Fund to conservation efforts (see Section 3.2.2). The introduction and adjustment of necessary user fees (e.g., waste collection and disposal – see Section 2.4.1), fines, and environmental licensing fees, applying the "polluter pays" principle (see Section 4.5), should also be considered. Such reforms have the potential to reduce market distortions, internalize externalities, and ultimately have positive impacts on the environment. However, fiscal reforms should carefully consider potential impacts on different social groups, and in relevant cases, compensation to vulnerable and low-income households should be contemplated to mitigate adverse effects from fiscal reforms. The Maldives would benefit from the establishment and implementation of a conservation and climate adaptation trust fund. Such a trust fund dedicated to ecosystem and protected areas management, biodiversity conservation, and climate adaptation efforts, would support resource mobilization from other funding sources. With both a sinking fund and an endowment fund window, different groups of donors and investors could be attracted, allowing for a good balancing between short-term and long-term investment priorities. The Maldives can learn from similar endowment funds , such as the Bhutan Trust Fund for Environmental Conservation, to design innovative mechanisms for sustainable finance of conservation and climate adaptation programs in the Maldives over the long-term.

Box 25. Conservation trust fund for the Maldives

Conservation Trust Funds (CTF) are private, legally independent institutions that provide sustainable financing for biodiversity conservation and support local climate action.[682] They receive, manage, and invest money from a variety of sources, including governments, international donors, and the private sector. Typically, these funds are pooled through green taxes, ecosystem service payments, government endowments, and impact investing among others.[683] The funds are then allocated to long-term conservation projects, primarily through grants. As their projects have evolved, CTFs have gone beyond just preserving habitats. CTF's initiatives across the world support biodiversity conservation, enhance local capacity, maintain ecosystem services, community well-being, build climate resilience, assist businesses in sustainable transitions, and partner with the private sector to promote eco-friendly practices. Depending on their setup in a country and the instruments they employ, CTFs can function as financial institutions, foundations, or charities. As these institutions mature, there is evidence that they foster innovation. If partnered with the private sector, they can also serve as incubators for new conservation strategies, ideas, and technologies. To ensure that funds are managed effectively, experts in financial management, marine biology, conservation, and the community must be involved. Support and participation from key stakeholders, such as local communities, NGOs, government agencies, as well as the private sector, are crucial to the credibility and effectiveness of the CTF.

683 Conservation Finance Alliance (CFA) (2020) https://static1.squarespace.com/static/57e1f17b37c58156a98f1ee4/t/5fc78161a038a451bcefe41d/1606910380954/CTF2020_Final.pdf

684 Spergel, B. and Mikitin, K. (2014). Practice Standards for Conservation Trust Funds. 2014 edition. Conservation Finance Alliance, New York

The Maldives' unique biodiversity and ecosystems bear significant environmental and economic significance, making it a compelling case for establishing a Conservation Trust Fund.

Over the past three decades, several conservation trust funds have been established worldwide, and their impact on conservation and climate adaptation has been significant. The Bhutan Trust Fund for Environmental Conservation (BTFEC), established in 1992 through a World Bank project, was the first of its kind, securing an initial $21 million grant from GEF, WWF, and bilateral donors.[684] By 2019, their investments in global and U.S. assets funded 249 projects, amounting to US$ 239.4 million, with a focus on training, awareness, and protected area management. In 1996, the Brazilian Biodiversity Fund (FUNBIO) was created with a $20 million GEF grant, supporting 411 projects over 25 years and benefiting 305 institutions across Brazil, including the noteworthy Amazon Region Protected Areas Program (ARPA).[685] In Madagascar, the Foundation for Protected Areas and Biodiversity (FAPBM), started in 2005, manages 45 protected areas totaling 3.5 million hectares. With a 2022 capital of USD 139 million, FAPBM is the largest conservation trust fund in Africa and, in 2020, joined the Conservation Finance Alliance (CFA) to broaden its resource base.[686]

The Maldives' unique biodiversity and ecosystems bear significant environmental and economic significance, making it a compelling case for establishing a Conservation Trust Fund. Furthermore, as a SIDS, the country is inherently vulnerable to the impacts of climate change, necessitating a robust strategy to mitigate these risks. As custodians of the world's seventh-largest reef system, the country faces substantial threats to its endemic and globally significant biodiversity. These threats stem from challenges such as ocean heating, coastal dredging, overfishing, and limited monitoring capacities. Additionally, burdened by high debt and challenging macroeconomic conditions, the Maldives is further strained by its over-reliance on tourism—a sector that heavily depends on Blue Natural Capital for its revenues and employment. Present conservation and climate funding mechanisms in the Maldives do not entirely align with global best practices, falling short in generating the necessary resources. CTFs acknowledge this interconnectedness and can provide a stable funding stream for environmental initiatives, insulating them from variations in tourism income.[687] CTFs could enhance the nation's institutional and technical capacities, invest strategically in its natural assets, unlock additional international funding without exacerbating debt, diversify its economy with fresh investment avenues, and, crucially, operate based on international best practices to ensure sustainability and large-scale resource mobilization.

The Baa Atoll Conservation Fund (BACF)[688] experience can provide valuable insights into the challenges and considerations for future Maldivian CTF. Established in 2013, BACF promotes the conservation of the Baa Atoll ecosystem, which has been a UNESCO-recognized Biosphere Reserve since 2011. This fund, operating under the Republic of Maldives' Public Finance Act, seeks to preserve the atoll's biodiversity and cultural heritage. BACF has played an important role in supporting the Baa Atoll Biosphere Reserve by distributing resources across the following core areas: 30% each to the reserve's management, the protection of the atoll's biodiversity, and livelihood enhancement for Baa Atoll residents, with the remaining 10% directed towards research, awareness, and educational outreach efforts. The fund's revenue

685 Namgyal, T. S. (2001). Sustaining conservation finance: future directions for the Bhutan trust fund for environmental conservation.

686 The Brazilian Biodiversity Fund (2023) https://www.funbio.org.br/en/who-we-are/

687 FAPBM (2023) https://www.fapbm.org/en/who-are-we/ FAPBM (2023) https://www.fapbm.org/en/who-are-we/

688 Bladon, A., Mohammed, E.Y. and Milner-Gulland, E.J. (2014). "A Review of Conservation Trust Funds for Sustainable Marine Resource Management: Conditions for Success." International Institute for Environment and Development, IIED Working Paper. London

689 Vorhies, F. (2020). Sustainable Conservation Financing in the Maldives. Malé, Maldives: IUCN and Government of Maldives. 68pp. http://www.environment.gov.mv/v2/wp-content/files/publications/20210228-pub-sust-consrv-financing-in-maldives.pdf

For the Conservation Trust Funds to thrive in the Maldives, it's imperative to diversify funding avenues, improve governance, and emphasize transparent reporting.

streams primarily from tourism-related charges (like access permits and filming permits), government contributions, and private sector partnership fees. In 2015, it disbursed MVR 598,869.00 ($38,471.34) for conservation activities.[689] The BACF has experienced successes but also highlights potential challenges for upcoming CTFs in the Maldives. These challenges encompass bureaucratic overheads, an overwhelming dependence on tourism-based revenues, limited involvement from non-local Baa Atoll users. For the CTFs to thrive, it's imperative to diversify funding avenues, improve governance, and emphasize transparent reporting. Alongside these, instituting management plans for PAs, defining clear roles, and ongoing staff training and local capacity enhancement are essential.

BACF's sustainability is in question due to its heavy reliance on the tourism sector. In Table 25, we provide some possible avenues to explore for enhancing financial sustainability.

Table 25. Financial mechanisms to support CTFs

Financing Mechanism	Description	Challenges and Considerations
Eco-Tourism Certifications	Awards eco-labels to environmentally compliant resorts and operators.	Needs robust monitoring systems.
Voluntary Visitor Contributions	Engages tourists directly in conservation.	Revenue consistency due to voluntary nature.
Payment for Ecosystem Services (PES)	Creates a financial link between ecosystem beneficiaries and providers.	Complexities in quantifying ecosystem services.
Crowdfunding Platforms	Provides global outreach for conservation projects.	Relies heavily on effective marketing strategies.
Corporate Partnerships	Taps into business resources, especially from the tourism sector, for conservation funding.	Ensuring alignment of business and conservation goals.
Carbon Offsetting Programs	Addresses climate change and conservation, targeting eco-conscious tourists.	Requires rigorous verification systems.
Marine Conservation Licenses	Generates revenue from marine-related activities like diving.	Challenges in enforcement and consistent monitoring.

The Maldives hasn't fully tapped into many possible international financial mechanisms. By establishing a flexible and dynamic CTF, the Maldives could access untapped funds from entities like GEF, GCF, CIF, Adaptation Fund, bilateral donors, and philanthropies. Other mechanisms, like Eco-Tourism Certifications, Voluntary Visitor Contributions, Payment for Ecosystem Services (PES), Crowdfunding Platforms, Corporate Partnerships, and Carbon Offsetting Programs, offer viable alternatives. However, these should be approached with caution to ensure they don't inadvertently siphon resources from other vital funds or governmental agencies. It's essential that these resources be viewed as supplementary, unlocking them based on the successful models implemented in other nations.

690 Vorhies, F. (2020). Sustainable Conservation Financing in the Maldives. Malé, Maldives: IUCN and Government of Maldives. 68pp. http://www.environment.gov.mv/v2/wp-content/files/publications/20210228-pub-sust-consrv-financing-in-maldives.pdf

The Maldives intends to issue sustainable bonds in the coming years. These sustainable bonds, also known as use-of-proceeds (UoP) bonds, are financial instruments where the proceeds are earmarked for use towards achieving green or social outcomes.

Over half of Maldives' multilateral debt is concessional, but only about 14 percent of bilateral debt is owed on concessional terms. The Maldives' primary bilateral creditor is China, which holds far more than any other single lender, though India and Saudi Arabia also hold sizable positions. The Maldivian commercial debt is split between foreign currency-denominated bonds and privately placed loans, many of which are issued under Islamic financial terms. With the retirement of the Sunny Side bond in 2022, the remaining Eurobond series, set to mature in 2026, was also issued as *sukuk*. Given that only a small percentage of the Maldives' debt is concessional, the government may consider seeking more concessional borrowing in the future, as opposed to incurring more debt at market rates, in line with the recommendations of the most recent World Bank/IMF debt sustainability analysis.

The Maldives intends to issue sustainable bonds in the coming years. These sustainable bonds, also known as use-of-proceeds (UoP) bonds, are financial instruments where the proceeds are earmarked for use towards achieving green or social outcomes. This includes green bonds, blue bonds, and social bonds. Regardless of their contribution to the country's Blue Economy, the use of funds raised from Maldives' previous sovereign bond issuances was not earmarked towards specific purposes. However, a change was announced in late 2022, with the government intending to issue green and blue bonds to assist in decreasing its budget deficit in the following years.[691] Although the government is still finalizing its sustainable financing framework for issuing these instruments, the stated goal is to finance about 7 percent of the deficit by issuing green and blue bonds worth MVR 771 million (about US$ 50 million) cumulatively over the next three years.[692]

As the government finalizes its sustainable financing framework, it could be beneficial to incorporate some flexibility into the design of individual instruments. UoP bonds typically offer only a modest reduction in borrowing costs compared to conventional bonds, but they also impose limitations on how the proceeds can be used. For example, Benin has been lauded for its comprehensive SDG Bond Framework, which supported its first SDG Bond issuance in 2021. Despite a supportive analysis from an Environmental, Social and Governance (ESG) service provider (V.E., a subsidiary of Moody's Corporation) and a detailed plan for financing 15 out of 17 SDGs in the country, however, the bond has been assessed by an investment bank (Natixis) to provide a discount of 0.2 percentage points off their normal cost of borrowing.[693] This suggests that the benefits of issuing such a bond are relatively minor given the constraints that come with it. It's important to remember that this assessment relies on a single methodology, indicating that Benin's actual borrowing discount could

691 Shareef, J., & Ismail, F. (2022). Maldives to introduce green and blue bonds make up deficit. Rashu. https://www.rashu.mv/article/9525

692 Atoll Times. (2022). Maldives to sell first eco bonds to finance 8. 4 billion deficit. https://atolltimes.mv/post/business/935

693 Merle, C. and Caumes, A. (2021). Republic of Benin's trailblazing €500m 12,5-Y inaugural issuance under its new SDG Bond Framework.https://gsh.cib.natixis.com/our-center-of-expertise/articles/republic-of-benin-s-trailblazing-500m-12-5-y-inaugural-issuance-under-its-new-sdg-bond-framework

Alternatively, it might be worthwhile for the Maldives to expand the parameters of its upcoming sustainable financing framework to include complex KPI-linked instruments, such as sustainability-linked bonds .

be even less. Given the very minor advantage to utilizing this structure, the Maldives may not want to bind itself to restrict the use of its proceeds from borrowing in such a way. Considering alternative structures in the future that offer more budgetary flexibility and potentially lower borrowing costs could be advantageous.

Photo Description: Distant island © World Bank

Alternatively, it might be worthwhile for the Maldives to expand the parameters of its upcoming sustainable financing framework to include complex KPI-linked instruments, such as sustainability-linked bonds (SLBs). Unlike traditional Use of Proceeds (UoP) bonds, SLBs link the intended environmental or social outcomes of the bond to its financial features. The financial advantage for the issuer of an SLB is contingent on demonstrable real-world success, in contrast to the UoP approach, which assumes that funds will drive desired results, aiming for a lower borrowing cost from the outset. SLBs utilize key performance indicators (KPIs), each supporting one or more sustainability performance targets (SPTs), allowing a second-party auditor to measure the impact of the issuer's environmental efforts. This independent auditing framework increases transparency to investors, reassuring potential donors who want to ensure their contributions are effectively utilized. Hence, SLBs are particularly suitable for guarantees and other forms of credit enhancement. The SPTs can be derived from the issuer's environmental goals. For corporate issuers, these often relate to measures such as reaching net zero emissions throughout a supply chain or converting production processes to sustainable practices. For sovereign issuers, SPTs can mirror official treaty-based targets, such as the Nationally Determined Contributions (NDCs), Sustainable Development Goals (SDGs), or Land Degradation Neutrality (LDN) targets. SLBs are still in their infancy, with only two sovereigns having issued SLBs as of 2022 (Chile and Uruguay). Although the Maldives may not be able to issue substantial new external commercial debt in the near future, it could still be beneficial to broaden the scope of its forthcoming sustainable financing framework. This framework plans to issue a series of smaller UoP bonds over the next few years, accommodating more sophisticated KPI-linked instruments later.

Debt swaps are transactions in which specific debt obligations are eliminated in exchange for actual, measurable climate or environmental accomplishments. Though the Maldives has yet to implement any form of debt swap, this transaction structure has proven advantageous to several other small island and coastal states, including Seychelles, Belize, and Barbados. These arrangements typically take two forms: bilateral swaps, involving debt forgiveness from a single creditor or a group of creditors, and multi-party swaps, involving a third-party donor institution. In multi-party swaps, this third-party institution—often an environmentally-focused NGO—purchases a segment of the country's existing debt and then reissues it with more favorable conditions. This latter structure tends to be more applicable when the debt is owed to commercial creditors. However, debt swaps must be handled with care since there is a risk that the market interprets this as a signal that the country may be in debt distress, potentially leading to lower creditworthiness ratings in the process.

Debt-for-Nature (DFN) swaps, a concept that originated in the late 1980s, have recently evolved to offer significant debt relief alongside their traditional environmental benefits. Originally, a debt swap typically involved an agreement between a creditor and debtor nation to redirect debt service payments towards conservation initiatives. While these arrangements rarely provided substantial alleviation of sovereign debt, due to the small cancellation of interest payments, the redirected funds could make considerable strides in conservation efforts. The prevalence of debt swaps globally declined with the emergence of more comprehensive debt relief mechanisms, such as the Heavily Indebted Poor Countries (HIPC) initiative. However, the recent accumulation of hefty sovereign debt burdens has reignited interest in this debt relief structure.

These newer debt swaps attempt to provide deeper debt relief in addition to conservation funding. These swaps often carry policy commitments and structured conservation programs besides direct financing. For instance, the multi-party DFN swap in Belize facilitated the retirement of its sole sovereign bond, the "Superbond," through the combined efforts of The Nature Conservancy (TNC), the US Development Finance Corporation (DFC), and Credit Suisse. TNC repurchased the Superbond from Belize's bondholders via a wholly owned subsidiary, BBIC, using funds raised by Credit Suisse through a blue bond issuance. The terms of the bond were revised to be more favorable for the Belizean government, with credit enhancement provided by DFC, additionally setting up a conservation trust. In exchange, Belize made several policy commitments for marine conservation, devised with assistance from TNC, through a comprehensive marine spatial plan (MSP). Although the Belize DFN swap did not entirely restore the country's debt sustainability, the transaction was substantial given the nation's economy size, and the Superbond's low trading value at the time allowed for a discounted buyout. In the future, such transactions could potentially be incorporated into a deeper restructuring, with additional outcomes for climate and nature.

The scaling up of the traditional swap mechanism is timely, particularly in an age when heavy debt burdens are largely contributing to many countries' inability to finance their climate and nature goals. For this reason, a DFN swap could be an attractive option for Maldives, whose current debt burden might otherwise prohibit it from issuing new non-concessional debt in any sizable quantity. Outside of distressed scenarios, pursuing a commercial DFN swap when bonds are trading high could potentially carry credit risks, even though official development partners may be more amenable to such a transaction due to the policy and conservation benefits it brings. However, some bondholders may still be inclined to exit what they perceive as a particularly risky position in favor of an upfront cash settlement, albeit at a discount. As the Maldivian government aims to reduce its significant budget deficit, a decrease in annual debt service obligations could offer a welcome solution.

Alternatively, structured impact bonds, such as the World Bank's Wildlife conservation bonds (WCBs), are a recent innovation that can help finance biodiversity conservation without adding to the Maldives' debt burden. When structured impact bonds are issued, a donor institution (such as the WB) issues a bond against its own balance sheet, then pays the coupon installments directly to the implementing agency within a beneficiary country. The private investors who purchased the bond would then receive a proportional return based on the success of the associated conservation initiative. This bond type has been issued (the "Rhino Bond") to support the conservation of black rhinoceros in South Africa, which received the bond's combined interest payment of around US$ 10 million upfront to help it in its efforts to conserve the species. Upon maturity, bondholders will receive an additional premium based on the success of conservation efforts.

Opportunities for the Maldives to sell carbon offsets on the international voluntary carbon market (VCM) are likely limited (see Section 3.3). Participants in the VCM buy and sell carbon offsets, or verified emissions reductions (VERs). Each VER represents one metric ton of carbon emissions (or the carbon equivalent of other greenhouse gas emissions) that has been offset by carbon-reducing activities elsewhere in the world. Given the Maldives' scarcity of expansive terrestrial forests and agricultural lands – conventional sources for offset generation – it faces some constraints in generating funds through this method. However, the emerging field of blue carbon conservation projects offers some potential. The first robust methodology for assessing such projects debuted in 2020.[694] However, blue carbon opportunities are likely limited in the Maldives because the relatively high transaction costs overshadow the financial benefits of small-scale restoration projects. The total extent of eligible ecosystems is also comparatively small in the Maldives so that the potential of this source of financing is limited.

694 Verra. (2020). First Blue Carbon Conservation Methodology Expected to Scale Up Finance for Coastal Restoration & Conservation Activities. Verra. https://verra.org/first-blue-carbon-conservation-methodology-expected-to-scale-up-finance-for-coastal-restoration-conservation-activities/

Table 26. An overview of non-debt and debt instruments.

Non-debt instrument	Debt instruments
Expenditure reforms: reforms to Aasandha, reducing and rationalizing subsidies to SOEs – especially for fuel and food subsidies, and a solid public investment management framework – are amongst the key reform areas to bring down the high levels of public expenditure, replenish fiscal buffers against future shocks, and lower the cost of growth-enhancing investments	Concessional loans
Revenue mobilization: diversifying the tax base and mobilizing more domestic sources of revenue, reducing informality, and enhancing the tax morale and equity of the tax system	Sustainable bonds: broadly encompasses bond structures in which the borrower declares its intention to put the bond proceeds towards achieving some sort of impact-oriented result
Environmental fiscal reforms: reforming subsidies to be more targeted,increasing Green Tax revenue, etc.	Sustainability-linked bonds: unrestricted use of proceeds but conditions depend on achieving sustainability outcomes
Grants: such as Green Climate Fund (GCF), Adaptation Fund (AF), Global Environment Facility (GEF), etc.	Blue bonds (e.g., the Seychelles in 2018 raised US$ 15M to fund the transition toward more sustainable fishing)
Carbon offsets: seeking financing for conservation from the entities that pursue projects that would otherwise cause a net loss in biodiversity or carbon equivalent emissions	Debt-for-nature swaps: cancellation of certain debt obligations in exchange for tangible climate or nature result on the ground

Source: Convention websites.

5.4 Recommendations

Short-term recommendations

Formulate and implement a comprehensive financing plan, taking into account a proper public investment management framework. This should begin with a detailed analysis of goals that have yet to be achieved, a concrete plan for coastal protection and a cost assessment of currently unmet NDCs. Some of the government budget for the coming years is reserved for coastal protection projects across the country (see Section 2.3), but a medium-to-long term plan is yet to be developed. Over the next few years, Maldives should also continue to follow through with its externally funded projects. This means ensuring that capacity-building programs indeed result in increased capacity and development projects are carried to completion. Demonstrating positive outcomes is a powerful way to present the Maldives as a desirable destination for future investments and grants. If the aforementioned costing exercise is executed effectively, it can serve as a powerful tool to attract additional funding in the future.

Consider financing selected biodiversity conservation targets with a Wildlife Conservation Bond (WCB). With at least 29 endangered or critically endangered species, Maldives would have plenty of choices as the focus of its own WCB. A WCB could not only help the preservation of specific species, but also reduce the financing gap for the conservation of marine ecosystems in existing or new protected areas (see Section 3.1.2). Although the amount of money generated for the Maldives would essentially qualify as a grant, it would still help the country's reputation as a target for such instruments if the initiative were successful, meaning that the size of an endangered population increases, and the bondholders see a good return.

Conduct an in-depth analysis of the desirability of other financing instruments, such as use-of-proceeds bonds (e.g., green and blue bonds) and debt-for-nature swaps. The desirability of these instruments should be carefully evaluated in terms of how much additional funds these instruments generate, as well as the costs and risks involved. For example, the execution of a debt-for-nature swap may be perceived as a signal of an increased chance of default, causing investors to demand higher interest rates on bonds issued by the Maldivian government. Use-of-proceeds bonds, such as Blue Bonds, may generate only a very small borrowing discount compared to standard bonds, so that this benefit may not weigh up to the inherent restriction on the use of bond proceeds.

Medium- to long-term recommendations

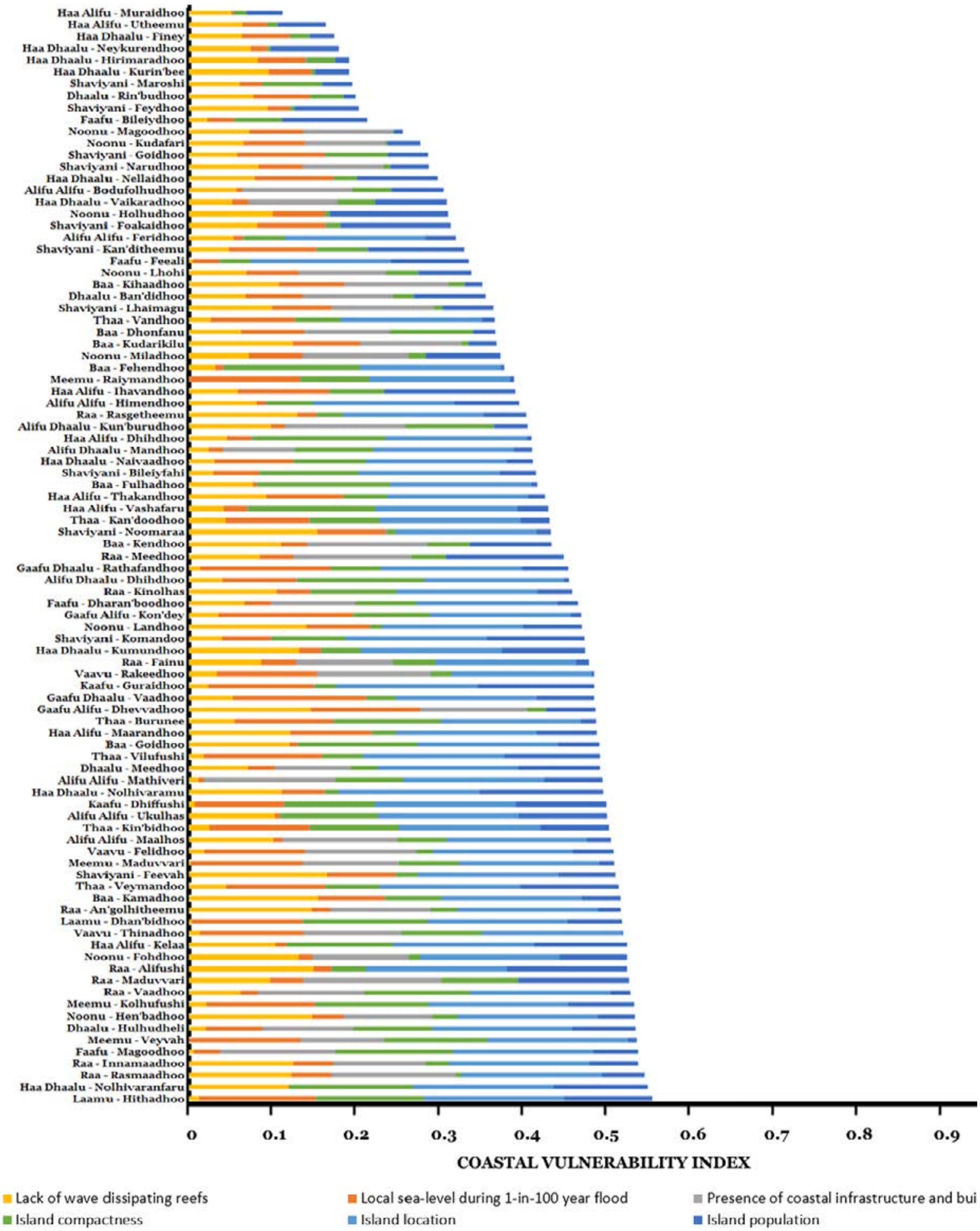
Establish a dedicated trust fund to mobilize resources for conservation and climate adaptation efforts to protect the Maldives' core competitive advantage. A conservation and climate adaptation trust fund with both a sinking fund and an endowment fund window may attract a wide range of donors and investors, contributing to the sustainable financing of both short-term and long-term conservation and climate resilience priority activities from concessional, philanthropic, and private sector resources.

Exercise great caution when considering returning to debt markets and consider sustainability-linked bonds as an innovative financing instrument. While Maldives' sovereign debt is currently evaluated to be sustainable by the IMF/World Bank debt sustainability analysis, the country is still discouraged from taking on new non-concessional debt, as the country is still at high risk of debt distress. The government's three-year plan to finance the deficit largely through new domestic debt greatly increases the risk of contagion across the banking system should a debt crisis eventually befall the country. This plan also includes the sale of new green and blue bonds, to be underpinned by a new sovereign sustainable financing framework. However, green and blue bonds are restrictive in terms of how the proceeds may be used. This aspect may be benign, given that a large portion of the government's expenditure needs over the next several years likely involvesdeveloping its Blue Economy and achieving its NDCs. More flexibility would still be preferable though, since the intention of these issuances is to finance a spending deficit. Sustainability-linked bonds may therefore be more suited to the country's needs. They not only permit free allocation of bond proceeds, but the associated external auditing also enhances transparency concerning the connected climate and nature projects. This increased transparency can eventually reduce borrowing costs.

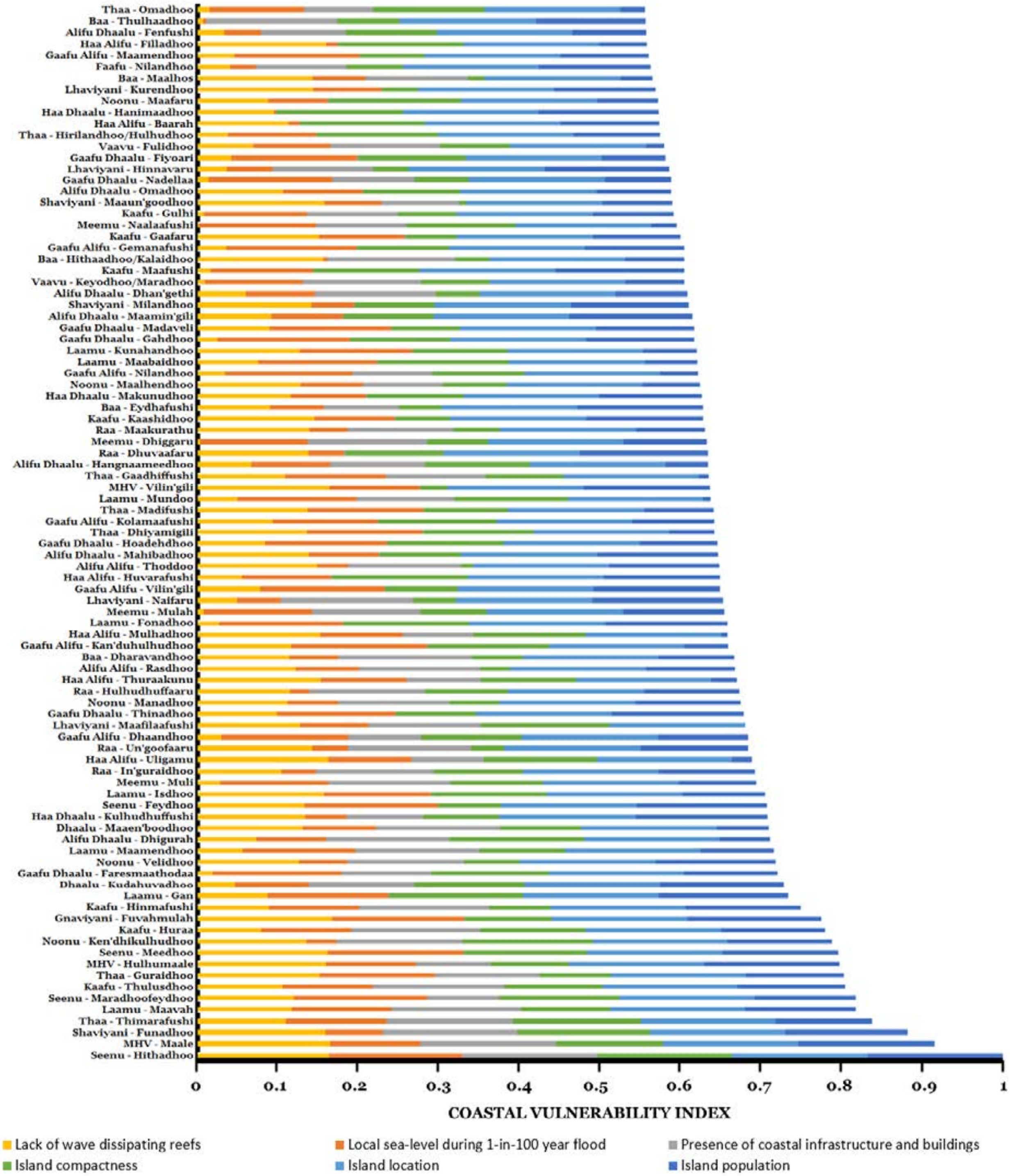
Along with ongoing government efforts for fiscal consolidation, review opportunities for effective and inclusive environmental fiscal policy reform. Environmental objectives should play an important role in the wider tax reform agenda that was proposed in a 2022 Goods and Services Tax review across all economic sectors in the Maldives. The Medium-Term Fiscal Strategy (MTFS) and the Medium-Term Revenue Strategy (MTRS) that are periodically prepared by the Ministry of Finance identify fiscal and revenue goals and associated challenges for the medium-term. Environmental taxes do not only internalize the unwanted side effects of pollution products into market prices, but also generate government revenues. The MTFS and MTRS should explicitly consider the role of tax revenues and better targeted government spending in meeting the country's climate and nature objectives. Furthermore, a number of environmental fiscal policy reforms, including the removal of fossil fuel subsidies for fishing vessels, and the reassessment of the need and impact of floor fish prices; the adjustment of the Green Tax to more optimally reflect environmental damages from tourism, and a higher share of Green Fund directed to conservation efforts; the introduction and adjustment of any needful user fees (e.g., waste collection and disposal), fines, and environment licensing fees applying the "polluter pays" principle should be considered. Such reforms should consider distributional impacts and be accompanied by adequate mitigation measures (e.g., social protection, short term compensation, and targeted and conditional cash transfers to affected low-income households).

Conduct an in-depth analysis of the desirability of other financing instruments, such as use-of-proceeds bonds (e.g., green and blue bonds) and debt-for-nature swaps. The desirability of these instruments should be carefully evaluated in terms of how much additional funds these instruments generate, as well as the costs and risks involved. For example, the execution of a debt-for-nature swap may be perceived as a signal of an increased chance of default, causing investors to demand higher interest rates on bonds issued by the Maldivian government. Use-of-proceeds bonds, such as Blue Bonds, may generate only a very small borrowing discount compared to standard bonds, so that this benefit may not weigh up to the inherent restriction on the use of bond proceeds.

Appendix A. Coastal Vulnerability Index by island



Source: World Bank.



Source: World Bank.

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