



# The intersection of marine and coastal conservation and nature-based solutions to climate change: Governance insights from Indian Ocean small island States<sup>☆</sup>

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## ABSTRACT

Despite an array of global interventions, climate change and biodiversity loss remain pressing environmental problems. Nations in the global south, and in particular small island developing states (SIDS), are frequently more vulnerable to climate change than other nations. Furthermore, these nations rely heavily on biodiversity for sustenance, livelihoods and economies. Yet, capacity and resources to address the challenges are often limited. Finding effective and efficient ways to respond to both climate change and biodiversity loss is, therefore, critical. This research explores nature-based solutions (NbS) to climate change and how these can simultaneously support marine and coastal biodiversity conservation. The paper focuses on international law and specifically the commitments made by Indian Ocean SIDS in their Nationally Determined Contribution documents (NDCs) submitted under the Paris Agreement. The commitments in these NDCs provide a foundation for climate change action, and now must be implemented if goals are to be achieved.

## 1. Introduction

Climate change and biodiversity loss are both pressing environmental problems. The impacts are felt at global, national, provincial and local levels, yet not all countries are impacted equally. The nations in the global south, and in particular small island developing states (SIDS),<sup>1</sup> are frequently more vulnerable to climate change than others, and their heavy dependence on biodiversity for sustenance, livelihoods and economies means that the loss or degradation of flora and fauna is more profoundly felt (Cherian, 2007). Yet, capacity and resources to address the challenges are often limited in these countries (UNFCCC, 2005). In this context, finding ways to simplify and integrate responses to both climate change and biodiversity loss is critical. One way in which this may be achieved is by utilising nature-based solutions (NbS) to climate change. This paper draws on the IUCN interpretation of NbS to climate change, defined as actions to protect, sustainably manage, and restore natural and modified ecosystems to address the impacts of climate change, benefiting both biodiversity and human well-being (<https://www.iucn.org/our-work/nature-based-solutions>). Rather than construct engineered solutions such as seawalls, instead mangroves, seagrasses, seaweeds and coral reefs can absorb some of the energy from the ocean and prevent storm surges and coastal erosion, while conserving and restoring coastal habitats such as salt marshes and dune systems can protect against flooding (Wedding et al., 2022). For SIDS, adapting to climate change by conserving marine and coastal ecosystems could provide significant co-benefits. NbS can also contribute to climate change mitigation because living marine flora naturally sequester carbon and thereby provide an ecosystem service by absorbing greenhouse gases (GHGs). Although SIDS tend not to be high emitters of GHGs, they can contribute to global goals through mitigation solutions, and as will be seen below, have already committed to doing so. NbS may be, therefore, an efficient and effective way in which resource poor nations, such as SIDS, can achieve multiple, beneficial environmental outcomes.

This paper seeks to advance knowledge of commitments made to NbS by exploring and analysing Nationally Determined Contribution

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<sup>1</sup> SIDS have been defined as a distinct group of UN member states facing unique social, economic and environmental vulnerabilities: UN Office of the High Representative for the Least Developed Countries, undated.

documents (NDCs) submitted by the Indian Ocean SIDS pursuant to obligations under the Paris Agreement. The Indian Ocean region is home to globally significant percentages of marine and coastal biodiversity, which is being impacted by habitat loss, coastal developmental, resource overextraction, and coastal pollution and climate change, exacerbated where environmental governance is weak and populations are growing (Wafar et al., 2011). The Indian Ocean SIDS are geographically diverse but tend to be heavily dependent upon healthy marine and coastal ecosystems that support fisheries which in turn contribute to food security, local livelihoods and national economies (Techera, 2020). Furthermore, these States have committed strongly to blue economy futures which will rely on healthy ecosystems but could also cause further impacts on the ocean environment (Techera, 2019). The coastal zones in these nations are particularly vulnerable to the impacts of climate change, such as extreme weather events and storm surges causing coastal erosion and flooding. It is in this area where multiple benefits can be achieved through NbS to climate change which necessarily involve marine and coastal conservation.

This article is exploratory in nature, involving a desk-based analysis of commitments made by the five Indian Ocean SIDS in their key NDCs to determine the extent to which synergistic approaches have been embraced by these States.<sup>2</sup> The research identifies where climate change commitments have been made which simultaneously involve biodiversity conservation. The specific emphasis is upon marine and coastal ecosystems as these are critical in a SIDS context and have significant potential to contribute to NbS in terms of both mitigation and adaptation. The issues are addressed through a governance lens and, therefore, NDC commitments to law, policy and institutional change are also examined.

The article commences by summarising existing literature and the methods utilised in this research in section 2. Section 3 provides an overview of international law obligations and global interventions at the intersection of these two environmental challenges. Section 4 introduces the NDCs in the region and, thereafter, sets out the relevant commitments made by Indian Ocean SIDS in the areas of marine and coastal ecosystem conservation and NbS. Section five provides the analysis of the findings, drawing out examples of where the synergies and co-benefits have been considered, and options to move forward. The paper concludes by highlighting the significance of NDC commitments and their analysis, as well as the need for further research and sharing of experiences both with and beyond the region.

## 2. Materials and methods

### 2.1. Literature

NbS are gaining traction because they have the potential to contribute broadly to environmental, cultural and socio-economic outcomes (Riisager-Simonsen et al., 2022). Scientific scholarship supports the potential for NbS to provide the above synergies, but the precise value of NbS has not been assessed (Seddon et al., 2020). Furthermore, not all marine and coastal NbS have the same potential to contribute to climate change adaptation and mitigation. In particular, there are difficulties in measuring the effectiveness of NbS in a scientific sense, and even where data is available, it is clear that not all marine and coastal ecosystems, and NbS projects associated with them, provide equal benefits (Gattuso et al., 2018). Furthermore, there are challenges associated with supporting financing and investment in NbS (which in part rely on scientific evidence), and barriers associated with the lack of integrated, cross-sectoral governance, and mismatches across scales of governance, can hinder the uptake of NbS. The economic cost is one

matter, including the relative cost of NbS vis-à-vis engineering solutions, but so too are the trade-offs of, for example, enhancing one coastal environment over another. Marine and coastal ecosystems that are of good quality and well-managed will likely remain more resilient in the face of climate change and therefore be able to contribute to multiple outcomes in greater ways than degraded ecosystems. But the long-term resilience of different marine and coastal ecosystems in the context of a changing environment varies and must be taken into account (Gattuso et al., 2018). Furthermore, climate change is likely to impact upon different States and environments to varying extents and this is also a matter that will affect the efficacy of NbS.

The above are all complex issues and, clearly, further research is needed to gather existing data, measure the effectiveness of various NbS, to build capacity (including through financing) and to overcome governance obstacles (Seddon et al., 2020; Riisager-Simonsen et al., 2022). However, such research will rely, in part, on implementation of NbS to provide the basis for further study. The present research seeks to identify which Indian Ocean SIDS have committed to NbS, and in what ways, as a precursor to implementation. Furthermore, this paper identifies the Indian Ocean SIDS that have recognised and sought to respond to governance challenges. In these ways, this research identifies those nations that might provide the context for subsequent research and evaluation.

The UNFCCC has analysed high level findings in its NDC Synthesis Reports (UNFCCC, 2021; UNFCCC, 2022b), and the Asian Development Bank has produced an analysis for its members (Amponin and Evans, 2016). Yet these reports do not explore the text of individual NDCs and/or do not cover the Indian Ocean region. Published analyses of ocean-based solutions to climate change do not include all Indian Ocean SIDS (Ocean Conservancy, 2021). Some literature covers SIDS (Robinson et al., 2022) but does not focus explicitly upon the intersection of marine and coastal conservation and NbS to climate change (Atteridge et al., 2020). Indeed, some research suggests that engineered solutions to coastal erosion are preferred to NbS in these states (Betzold and Mohamed, 2017),<sup>3</sup> and that blue carbon mitigation options are nascent (The Blue Carbon Initiative, undated).<sup>4</sup> In addition, some studies focus on the ways in which NbS can contribute to the achievement of both climate change and biodiversity conservation commitments under the two international law regimes; but again SIDS are not mentioned (Ter-ton et al., 2022). The present research contributes to better understanding of all these areas as they relate to the Indian Ocean SIDS. Other published articles focus on responses to climate change more broadly, rather than linking these to law, policy and governance initiatives (Poti et al., 2022). The present research, as a desk-based analysis, is a first step in addressing the gap in the literature on the Indian Ocean SIDS' NDCs with respect to their commitments at the intersection of marine and coastal conservation and nature-based solutions to climate change. In particular, this research was inspired by a global analysis of NDCs, focusing on marine and coastal ecosystems and NbS (Lecerf et al., 2021). However, that report included only two Indian Ocean SIDS and so all five nations are included here.

## 3. Methodology

The NDCs were accessed via the [UN Climate Change](#) NDC Registry

<sup>2</sup> Under Articles 3 and 4 of the Paris Agreement, States are to develop and communicate ambitious nationally determined contributions to support the global response to climate change.

<sup>3</sup> This paper refers to other studies in the Maldives: Sovacool BK (2012) Perceptions of climate change risks and resilient island planning in the Maldives. *Mitig Adapt Strateg Glob Change* 17:731–752 and Kench P (2012) Compromising Reef Island shoreline dynamics: legacies of the engineering paradigm in the Maldives. In: Cooper JAG, Pilkey OH (eds) *Pitfalls of shoreline stabilization: selected case studies*. Springer, Dordrecht, pp 165–186.

<sup>4</sup> Bodies such as The Blue Carbon Initiative are seeking to support science and policy developments. See, for example, <https://www.thebluecarboninitiative.org/policy-guidance>.

<https://unfccc.int/NDCREG>). A series of specific search terms were applied in three broad areas as set out in Table 1 below. The focus of this research is upon law and legal approaches to achieve policy outcomes, rather than the application of education and financial policy levers, and so the search terms were selected with this goal in mind. References to, for example, 'blue carbon', 'carbon sink' and 'carbon sequestration' were chosen as they are words commonly used in law and governance approaches to climate change adaptation and mitigation. Similarly, 'marine', 'coastal', 'conservation', 'protection' and 'restoration' were selected because they feature in legal frameworks aimed at addressing biodiversity loss. Specific searches were conducted for 'nature-based' and 'law', 'legislation', 'governance', 'policy' and 'regulation' address the particular focus of this research.

The high level results of these searches are included in Table 3, with summaries of key NDC commitments included in Tables 4–6. Table 7 includes extracts from national commitments related to improving governance.

### 3.1. Significance

It is recognised that the scope of the findings in this article are limited as only a desk-based analysis has been undertaken. Clearly, further research is necessary in relation to each jurisdiction, including empirical and locally-based analysis. Despite the limitations of this work, it is hoped that this paper will provide a foundation and springboard for future research on Indian Ocean SIDS. In addition, this research contributes to a broader body of literature on implementation of international law in regional contexts, in this case the Indian Ocean.

## 4. The international law context

International law has catalysed multiple interventions and responses to both biodiversity loss and climate change, including under the *Convention on Biological Diversity* (CBD) (<https://www.cbd.int/>) and the *Paris Agreement* (<https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>) pursuant to the *UN Framework Convention on Climate Change* (UNFCCC). These two international law

**Table 1**

Key areas of research and search terms used.

SEARCH TOPIC	SEARCH TERMS <sup>a</sup>
Marine and coastal ecosystem conservation	marine (l'océan, marin) coastal (côtiers, côtière, côte) ecosystem (écosystèmes) conservation protection restoration (la reconstitution)
Nature-based solutions (NbS)	NbS nature based (les solutions fondées sur la nature, solutions ancrées dans la nature, solutions basées sur la nature)
NbS - adaptation	buffer barrier (barrière) coastal erosion (l'érosion des côtes) coastal protection (protection côtière/côtes) coastal defence (défense côtière/côtes)
NbS - mitigation	blue carbon (carbone bleu) carbon sequestration (sequestration) carbon sink (puits de carbone) ocean carbon storage (puits de carbone des océans) reservoir
Governance	law/legal (droit/juridique) legislation (législation) regulation (régulation) policy/policies (politique) governance (gouvernance)

<sup>a</sup> Comoros has submitted its NDC in the French language and therefore alternative search terms were necessary and are included in parentheses in Table 1.

**Table 2**

Indian Ocean SIDS' ratification of key international treaties and submission of NDCs.

STATE	CBD	UNFCCC	PARIS AGREEMENT	NDCs	
Comoros	1994	1994	2016	1st 2016	updated 2021
Maldives	1993	1992	2016	1st 2016	updated 2020
Mauritius	1993	1992	2016	1st 2016	updated 2021
Seychelles	1993	1992	2016	1st 2016	updated 2021
Singapore	1996	1997	2016	1st 2016	updated 2020

**Table 3**

References to search terms in the five Indian Ocean SIDS' NDC documents.

State	Marine and coastal ecosystems	NbS - adaptation	NbS - mitigation
Comoros	X		X
Maldives	X	X	
Mauritius	X	X	X
Seychelles	X	X	X
Singapore	X	X	

regimes largely operate in parallel, despite some efforts to link treaty regimes including under the banner of the 'Rio Conventions' (UNFCCC, undated; *Joint Liaison Group of the Rio Conventions*, undated; CBD, 2003). Even the Sustainable Development Goals (SDGs) separate targets related to living marine resources (SDG14) from those associated with climate change (SDG13) (<https://sdgs.un.org/goals>). This division can create challenges where obligations under one regime counteract responses under another.<sup>5</sup> Nevertheless, each regime has made some efforts to address cross-cutting issues, as set out below. A further challenge posed by lack of integration is that states are required to implement obligations under multiple instruments separately which places a heavy burden on (particularly developing) nations. The result is often limited domestic implementation which in turn undermines the achievement of global goals in both regimes. Adopting NbS to climate change offers a way for states to achieve goals under both regimes, and this has been recognised at the international level, discussed further below.

The CBD was adopted in 1992 and recognizes that the loss of biodiversity is a common concern of humankind. The treaty provides a regime that applies to all biodiversity (species, ecosystems and genetic components) with key objectives being the conservation of biological diversity, sustainable use of its components, and the fair and equitable sharing of the benefits of utilization of genetic resources (CBD Art 1). Rather than requiring the protection and management of listed species, areas or resources, individual provisions expand upon and provide guidance on how states could achieve the three objectives. It is recognised that most biodiversity exists within national jurisdictions and so commitments to developing National Biodiversity Strategic Action Plans (NBSAPs), and providing National Reports on implementation and actions, features throughout the treaty. This is significant as it is also a national approach that the climate change regime has adopted in requiring NDCs that set out state commitments and activities. All of the Indian Ocean SIDS have filed one or more NBSAPs and although none refer explicitly to NbS they do feature, unsurprisingly, interventions to address biodiversity conservation including in marine and coastal areas.

<sup>5</sup> An example of this is the phase out of chlorofluorocarbons under the Montreal Protocol, and their substitution for less ozone depleting gases (hydrofluorocarbons), which were later found to have a potent greenhouse effect. *Science Daily*, 2012.

**Table 4**  
Summary of references to marine and coastal ecosystems in NDC documents.

STATE	MARINE AND COASTAL ECOSYSTEMS
Comoros	<ul style="list-style-type: none"> <li>Sea level rise and coastal erosion are recognised as threatening coastal ecosystems, coastal forests, and coastal localities</li> <li>A vulnerability analysis demonstrates that the sectors most vulnerable to climate change are agriculture and biodiversity, followed by forests, coastal areas, and fisheries</li> <li>Monitoring and restoration of marine and coastal ecosystems is included as an adaptation action</li> </ul>
Maldives	<ul style="list-style-type: none"> <li>Maldives recognizes the importance of its marine flora and fauna with a significant focus on coral reefs, which are recognised as being impacted by sea surface temperature and other climatic factors. Fisheries are also recognised as being impacted by climate change</li> <li>Maldives commits to facilitating research to address knowledge gaps in reef ecosystems, strengthening monitoring, improving national conservation programs, enhancing resilience through the development of policy tools, and implementing pollution reduction measures</li> <li>Maldives also commits to facilitating fisheries research, enhancing diversification of the fisheries sector, promoting sustainable fisheries, facilitating access to financing to meet vulnerability challenges and strengthening insurance arrangements</li> </ul>
Mauritius	<ul style="list-style-type: none"> <li>Mauritius recognizes climate change risks and impacts to biodiversity</li> <li>Improved management of marine protected areas, expansion of the protected area network including rehabilitation of wetlands, seagrass and mangrove plantations, as well as coral reef rehabilitation and farming</li> <li>Mauritius also includes the institutional arrangements for fisheries and marine ecosystems, and the policy framework for adaptation actions and measures for fisheries, marine ecosystems, and coastal areas</li> <li>A commitment is made to establishing an integrated framework that combines fisheries sector, coastal zone management and marine biodiversity conservation, founded on the blue economy concept</li> </ul>
Seychelles	<ul style="list-style-type: none"> <li>Recognizes the centrality of marine and coastal ecosystems to sustainable development, resilience, human well-being and the vulnerability of the marine life which will affect commercial fisheries and tourism</li> <li>Seychelles commits to implementation of its Marine Spatial Plan and quantifies the marine protected areas it will effectively manage (30%), as well as protections for at least 50% of seagrass and mangrove ecosystems by 2025 and 100% of these ecosystems by 2030</li> <li>Seychelles also refers to integration, committing to a ridge-to-reef approach to coastal management that links the Marine Spatial Plan, the Coastal Management Plan, the Blue Economy Roadmap, and the National Biodiversity Strategy and Action Plan</li> <li>Refers to ecosystem services from coastal wetlands and marine resources in the context of blue habitats</li> <li>Commits to expanding and supporting marine and marine tourism-related education, data collection, monitoring and research on the impacts of climate change on marine biodiversity and ecosystems, as well as an assessment of the cost of loss of coastal and marine ecosystems</li> <li>Refers to the Seychelles Port Authority's Strategic Plan and Green Ports Initiative that enhances waste management and reduces marine pollution</li> <li>A policy gap is identified - land reclamation - to link to marine spatial planning</li> </ul>
Singapore	<ul style="list-style-type: none"> <li>Commits to biodiversity conservation goals by 2030 including recovery plans for over 70 more animals and plant species, enhancing 30 hectares of forest, marine and coastal habitats.</li> <li>Singapore is also conserving and restoring its mangrove forests</li> </ul>

More research is needed to map and analyse the commitments and activities set out in the NBSAPs against those in the NDCs.

Much of the work of the CBD is done through detailed work programmes one of which focuses on Marine and Coastal Biodiversity (<https://www.cbd.int/marine/>). Importantly, Climate Change and Biodiversity is recognised as a cross-cutting issue resulting in the preparation of technical papers and guidelines to assist member states respond to both crises (<https://www.cbd.int/climate/>). At the 2022 Conference of the Parties, COP15, the Kunming-Montreal Global Biodiversity Framework was adopted which includes four goals and 23

**Table 5**  
References to NbS to climate change adaptation in Indian Ocean NDCs.

STATE	NATURE-BASED SOLUTIONS TO CLIMATE CHANGE ADAPTATION
Comoros	<ul style="list-style-type: none"> <li>Notes that sea level combined with coastal erosion threatens coastal ecosystems, infrastructure, and most coastal localities</li> </ul>
Maldives	<ul style="list-style-type: none"> <li>Recognizes the risks of coastal hazards such as sea swells, sea level rise and the need for coastal resilience</li> <li>Commits to increasing resilience through better spatial planning, strengthening the legislative framework</li> <li>In the context of infrastructure resilience, Maldives also commits to strengthening conservation and restoration of mangrove ecosystems to act as buffers for flood mitigation</li> </ul>
Mauritius	<ul style="list-style-type: none"> <li>Development of sustainable landscape management and Ecosystem-based adaptation/nature-based solutions for Rodrigues</li> <li>Includes the mitigation co-benefits of adaptation actions, including biodiversity assessment and monitoring, implementation of ecosystem-based management, ecosystem restoration and planting</li> <li>Recognizes the role of NbS for adaptation and job creation and includes the potential of NbS in the 2021 Updated National Climate Change Adaptation Policy Framework</li> </ul>
Seychelles	<ul style="list-style-type: none"> <li>Blue Carbon Ecosystems - mangroves, seagrass and saltmarsh ecosystems - help to buffer against storm surges, filter water, shelter and nourish a wealth of biodiversity, providing economic opportunity and intrinsic value for communities whose well-being and livelihoods are tied to their healthy function.</li> <li>Coastal planning and infrastructure regulation will prioritize nature-based solutions for climate resilience</li> <li>Seychelles Climate Change Policy commits to adaptation measures, with NbS to climate change seen as a primary source of adaptation</li> <li>Seychelles commits to fostering technical capacity for planning and design of NbS</li> <li>A World Bank study identified limiting factors to coastal management planning and implementation including limited coherence between different pieces of legislation and limited technical capacity</li> </ul>
Singapore	<ul style="list-style-type: none"> <li>Singapore will continue to explore innovative approaches to coastal protection including a combination of conventional engineering solutions and NbS.</li> <li>Singapore will be naturalizing more waterways and waterbodies, coastal and riverine parks will also incorporate designs such as floodplains to protect coastal and low-lying areas from sea level rise or flooding, and conserving and restoring mangrove forests will help to dissipate waves as a flexible form of coastal defence while reducing erosion.</li> </ul>

targets to be achieved by 2030 (CBD, 2022). Three targets refer to the impacts of climate change, and in particular target 19 recognizes the interconnectedness by aiming to optimize 'co-benefits and synergies of finance targeting the biodiversity and climate crises'. Supporting NbS to climate change is one way to achieve these co-benefits.

The international efforts to address climate change through law and policy have been well-researched and are the subject of much literature (Nwabueze and Techera, 2021; Sands et al., 2018). In summary, the international community adopted the UNFCCC in 1992 (<https://unfccc.int/>). This Convention established a global benchmark and articulated a number of international commitments, with further detail added in the Kyoto Protocol ([https://unfccc.int/kyoto\\_protocol](https://unfccc.int/kyoto_protocol)). Subsequently, the Paris Agreement was adopted in 2015 establishing, for the first time, a mechanism that allowed individual states to set their own mitigation and adaptation targets in NDCs, provided that they contributed to the overarching global goals (<https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>). Although the Paris Agreement is a legally binding instrument, the only enforceable obligation is to submit an NDC document under Article 4(2). All signatories to the Paris Agreement have now done so, with several states subsequently filing revised or second NDCs (<https://unfccc.int/NDCREG>). All of the five Indian Ocean SIDS explored here have ratified the UNFCCC and Paris Agreement and submitted at least one (and frequently a second or revised) NDC document, as set out in Table 2. It is these NDC documents that are analysed in the sections that follow.

Under Article 4(2) of the Paris Agreement, States have an obligation to 'prepare, communicate and maintain successive' NDCs. Although the



**Table 6**  
References to NbS to climate change mitigation in Indian Ocean NDCs.

STATE	NATURE-BASED CLIMATE CHANGE MITIGATION SOLUTIONS
Comoros	<ul style="list-style-type: none"> <li>Comoros wishes to contribute to the international effort to combat global warming by pursuing its objective of being a carbon sink</li> </ul>
Maldives	<ul style="list-style-type: none"> <li>Inclusion of sources and sinks were considered based on the latest inventory (2015) and it was decided that more data gaps need to be filled and this will be addressed over time in subsequent inventory updates</li> </ul>
Mauritius	<ul style="list-style-type: none"> <li>Mitigation co-benefits include assessment and monitoring of blue carbon marine ecosystems, including mangroves, tidal marshes and seagrasses</li> <li>Commits to joint efforts (with local communities, NGOs) to restore ecosystems and, thus, carbon storage capacity (mangrove, forest, and coral reef rehabilitation)</li> <li>Commits to research regarding the potential of aquaculture for carbon sequestration and renewable aquatic energy (algal biofuels, hydropower and other aquatic-based energy systems that exploit the energy potential of tides, currents, waves and wind).</li> </ul>
Seychelles	<ul style="list-style-type: none"> <li>Seychelles acknowledges that coastal ecosystems need to be healthy, functional and maintained through protection in order to fulfill their critical roles for both climate change mitigation and adaptation</li> <li>Seychelles is committing to protect at least 50% of its seagrass and mangrove ecosystems by 2025 and 100% by 2030, with external support</li> <li>Seychelles new key contributions to climate change adaptation under this NDC include commitments and targets focused on safeguarding the Blue Economy and Blue Carbon ecosystems</li> <li>Seychelles will establish a long-term monitoring programme for seagrass and mangrove ecosystems by 2025</li> <li>Seychelles is committed to mapping the full extent of the blue carbon seagrass and mangrove ecosystems within its waters, through the application of pioneering new technologies, and sharing lessons learned to contribute to global understanding of the climate and ecosystem benefits provided by these ecosystems</li> <li>Carbon stock values will also be measured and included in the GHG sink of Seychelles' blue carbon ecosystems within the National Greenhouse Gas Inventory by 2025.</li> <li>Commits to identifying financing mechanisms to support its NDC implementation such as multilateral and bilateral funds, insurance products, debt-for-nature swaps, private investment, blue carbon credits and bonds, and other innovative conservation financing mechanisms.</li> </ul>
Singapore	<ul style="list-style-type: none"> <li>Notes that limited land space and high urban density provides little scope for the forestry sector to be a significant carbon sink</li> </ul>

commitments contained in the NDCs are not binding, their power lies in the flexibility they provide to States who can choose mitigation and adaptation options aligned with their national interest. Whilst this flexibility was important to secure global support for the Paris Agreement, the risk is that the combination of the commitments made by individual States might not be sufficient to prevent climate change. Indeed, the 2021 NDC Synthesis Report demonstrated that even if all NDC commitments were taken into account, GHG emissions would rise above 2010 levels and therefore fail to prevent a 1.5 °C temperature rise (UNFCCC, 2021). At UNFCCC COP26 in 2021, States agreed to 'revisit and strengthen' their 2030 targets by the end of 2022. At COP27 a further NDC Synthesis Report was adopted, the findings of which confirm that collectively the ambitions set out in NDCs improve on the position analysed in the 2021 Synthesis Report, but still fall short of what is needed to keep temperature rise below 2 °C (UNFCCC, 2022b).

The legal regime to address climate change includes a focus area on oceans, with National Adaptation Plan process including technical guidelines including some provided by the CBD, and the Nairobi Work Programme, a knowledge hub on adaptation and resilience, has a focus area on the ocean, coastal areas and ecosystems (<https://unfccc.int/topics/ocean/ocean-action-under-the-unfccc>). Relevantly, in March 2022, the UNFCCC Technology Executive Committee issued a draft policy brief on NbS that recognizes that climate change impacts compound other challenges and place further pressure on biodiversity (UNFCCC, 2022a). Some recommendations were made for governments, including the need to integrate adaptation solutions in climate change

**Table 7**  
Governance in Indian Ocean NDCs.

State	Governance
Comoros	<ul style="list-style-type: none"> <li>Notes that adaptation to climate change has been integrated into certain public policies and that Comoros undertakes to operationalize an intersectoral structure</li> </ul>
Maldives	<ul style="list-style-type: none"> <li>Commits to strengthening the legislative framework for infrastructure resilience by establishing a National Planning Act and Physical Planning Act to facilitate integration of climate change into development planning</li> <li>Commits to strengthening climate governance through enactment of climate change legislation</li> <li>Mainstreaming climate change risks into coastal development policies</li> <li>Enhancing resilience of coral reefs and ecosystems by developing policy tools</li> <li>Implementing measures to reduce sources of pollution on coral reefs and ecosystems especially marine life through appropriate policies</li> </ul>
Mauritius	<ul style="list-style-type: none"> <li>Notes that setting out the climate policy aspirations and strategies well in advance will help provide a clear sense of direction</li> <li>Notes the extent of legislation relevant to climate change adaptation, including the Climate Change Act, Environment Protection Act and National Disaster Risk Reduction and Management Act</li> <li>Commits to a strengthened regulatory framework to protect beaches, dunes, and vegetation relevant to tourism and coastal zone management</li> <li>Reports on the 2021 Updated National Climate Change Adaptation Policy Framework that focuses on the potential of nature-based solutions for adaptation, including developing and implementing an integrated approach combining fisheries, blue economy, tourism, biodiversity and coastal zone sectors,</li> <li>Commits to building on current adaptation policies including rehabilitation of degraded coastlines, and developing a coral restoration strategy,</li> <li>Identifies several barriers to the implementation of adaptation, including fragmentation within and between scales of governance, and commits to developing and implementing an integrated approach which combines tourism and marine biodiversity conservation with coastal zone management.</li> </ul>
Seychelles	<ul style="list-style-type: none"> <li>Recognition that success will depend upon improved governance, including coordination between various actors, building capacity for implementation, and incorporating knowledge in policy, law and regulatory frameworks.</li> <li>Reflection on policy implementation since 1992, including the updated Seychelles Climate Change Policy (2020), with a focus on building local capacity and the role of climate finance, as well as on sectoral policies that address climate resilience</li> <li>Seychelles Climate Change Policy (2020) commits to adaptation measures which recognise the importance of ecosystem services, adopt NbS to climate change and increase the resilience of critical habitats and ecosystems</li> <li>Commitment to develop and implement better and more appropriate integrated coastal zone management and new nature-based tourism and policies to protect critical infrastructure</li> <li>Commitment to develop programs to strengthen implementation planning, undertake a policy burden evaluation and create a network for all policy analysts to ensure coordination of policy development and implementation for marine and coastal ecosystems</li> <li>Coastal management and seabed mining policy and legislation is not up to date and a commitment is made to develop and/or amend relevant instruments</li> <li>Seychelles will build a national climate governance system, support transparent implementation by enacting dedicated legislation for comprehensive monitoring, reporting and evaluation of GHG data, as well as mitigation and adaptation actions, and to establish a cross-institutional climate governance framework</li> </ul>
Singapore	<ul style="list-style-type: none"> <li>Recognition of the importance of integrated governance - through coordinated, whole-of-government institutional arrangements, long-term planning and climate change policies - which provides a clear sense of direction</li> </ul>

policies with respect to marine protected areas and coastal risk reduction measures which could include NbS. At the 2022 COP27 meeting, NbS features strongly (Nature-Based Solutions Initiative, 2022). For example, the Presidency, together with IUCN, launched the Enhancing Nature-based Solutions for an Accelerated Climate Transformation

(ENACT) Partnership to foster knowledge sharing and collaboration ([https://www.iucn.org/sites/default/files/2022-11/enact-partnership-for-nbs\\_0.pdf](https://www.iucn.org/sites/default/files/2022-11/enact-partnership-for-nbs_0.pdf)). In addition, a specific session focused on addressing climate change and biodiversity loss through NbS (<https://www.naturebasedsolutionsinitiative.org/news/cop27-session-on-catalyzing-nbs-for-climate-and-biodiversity-action/>) and an interactive online global map of best practice examples NbS was launched (<https://casestudies.naturebasedsolutionsinitiative.org/>). These developments demonstrate the growing interest in NbS as a response to both the impacts of climate change and biodiversity loss.

## 5. The Indian Ocean SIDS' NDCs and commitments to NbS

As outlined above, five Indian Ocean SIDS' NDCs were explored through searches for the words as set out in Table 1. The high level findings are indicated in Table 3 and demonstrate that all five SIDS included two or more of the search areas, but that only two SIDS' refer to all of them. Notably, Singapore's NDC does not refer to blue carbon,<sup>6</sup> despite research having been undertaken on the nation's mangrove-related blue carbon potential (The Mangrove Lab, undated), and the announcement of joint Singapore-Indonesia blue carbon research (Yulisman, 2022). Similarly, the Maldives has been the subject of research on seagrasses as a carbon sink (Blue Carbon Lab, 2019) but the only reference notes a commitment to include all categories of emissions and removals but there are currently data gaps to be filled before doing so. Comoros refers to sea level rise and coastal erosion in its NDC, but not NbS to climate change.<sup>7</sup>

### 5.1. Marine and coastal ecosystems

Table 3 shows that all five SIDS refer to marine and coastal ecosystems in their NDCs. Summaries of the key references are set out in Table 4. All States recognise the importance of marine and coastal ecosystems and the threats to them posed by climate change. Some States include more detail about the diversity of such ecosystems. For example, the Maldives NDC includes separate sub-headings for coastal protection, coral reefs, and fisheries, each of which has associated commitments for conservation and management. In addition, a commitment is made to mangrove conservation in the context of infrastructure resilience. Seychelles also refers to specific ecosystems but in different ways: adaptation sub-headings for coastal management and fisheries, as well as in the context of blue carbon and NbS. Mauritius makes limited reference to coral reefs, but mangroves are included in terms of revegetation, blue carbon and protected area management. These variations, in part, reflect differing national priorities and concerns.

All of the NDCs refer to conservation and management of marine and coastal ecosystems, but only Mauritius and Seychelles commit to expanding areas of marine flora, although Comoros also refers to restoration more generally. Both Comoros and Maldives refer to monitoring. Maldives focuses heavily on addressing knowledge gaps through research, as well as various ways that it can enhance resilience.

Seychelles and Mauritius NDCs are more detailed than the other Indian Ocean SIDS. Mauritius takes a strong blue economy approach, which includes committing to integrated conservation and management approaches to fisheries, coastal development and biodiversity conservation. There is also more detail of the law, policy and governance arrangements for conserving ecosystems, and commitments to greater cross-sectoral integration.

Seychelles explicitly also outlines a range of plans, strategies and policies, as well as policy gaps, and the need for integration (of coastal

protection policies and projects and data that supports them, as well as in disaster planning and education for nature-based tourism development), and goes one step further by setting percentage protection goals and quantifying the costs of its adaptation actions. Although Singapore does include some quantitative goals, it is unclear how much is terrestrially-based versus marine and coastal. Indeed, many of Singapore's commitments to biodiversity conservation are quite general.

Mauritius and Seychelles are also the only States to note the specific legal tool of protected area management and marine spatial planning. Seychelles has produced the most detailed of the NDCs with respect to marine and coastal ecosystems, extending the scope of its commitments to education, marine-based tourism and critical infrastructure protection including for ports.

### 5.2. Nature-based adaptation solutions

All of the SIDS recognise the risk of climate change and the need for adaptation options. Table 5 summarises the references to nature-based adaptation solutions in SIDS' NDCs. Comoros does not refer to NbS to coastal threats, nor include any references to protection of coasts through living resources. The Maldives NDC does not specifically mention the term NbS but does refer to mangroves in the context of building coastal infrastructure resilience and notes the flood mitigation services they provide. Commitments to building resilience are included, interestingly, with reference to strengthening planning and law.

Mauritius only refers to NbS directly in two places, but more broadly indicates that nature-based adaptation actions are included in its *National Climate Change Adaptation Policy Framework*. Importantly, the job opportunities created by NbS are highlighted, as are mitigation co-benefits of adaptation actions. Seychelles comments upon the multiplicative benefits of marine ecosystems, linking them to marine health, blue carbon and buffering against storm surges. Seychelles refers to prioritising NbS as a primary adaptation option in terms of coastal infrastructure planning and adopting NbS in the *Climate Change Policy*. Seychelles also adopts the findings of a World Bank country study which highlighted the need for legislative coherency. Singapore makes some reference to coastal protection in relation to floodplains and does mention mangroves in relation to wave dissipation.

Although marine protected areas were noted as relevant to marine and coastal conservation, they are not referenced with respect to NbS, nor are any other specific legal tools. Seychelles, however, does commit to capacity building to plan and design NbS. Surprisingly, financing for NbS is not mentioned.

### 5.3. Nature-based mitigation solutions

All five SIDS refer to carbon sinks in their NDCs and Table 6 highlights key commitments. Comoros, however, simply refers to aiming to be a carbon sink with no specific reference to land or water, and Singapore refers only to its limited capacity to create terrestrial sinks. Maldives notes its desire to include all sinks, but that there are data gaps to be filled, and no specific commitments are made in the NDC.

Mauritius and Seychelles are much more sophisticated in their approaches, with Seychelles again setting quantitative and temporal targets. The inclusion of references to blue carbon fall into several categories. Again, Mauritius refers to mitigation co-benefits of adaptation, and commits to working with communities to restore marine and coastal ecosystems and by doing so build carbon storage capacity. Furthermore, Mauritius pledges that research will be undertaken in relation to the carbon sink potential of plant-based aquaculture. Specific attention is paid to renewable ocean energy production.

Seychelles' NDC includes a whole section dedicated to blue carbon as NbS to climate change together with specific percentage commitments and target dates. Critically, Seychelles appreciates that marine and coastal ecosystems must be healthy to contribute to climate change mitigation. Seychelles also links blue carbon to the blue economy.

<sup>6</sup> The only relevant reference is to forests as carbon sinks.

<sup>7</sup> Published literature suggests that engineered solutions dominate in Comoros: e.g., Betzold and Mohamed (2017).

Furthermore, it commits to long term ecosystem monitoring, mapping blue carbon stocks, and including blue carbon ecosystems in its GHG inventory by 2025. Identifying financing mechanisms is referred to in relation to nature-based adaptation solutions, including the potential of credits and bonds, and it is conceded that external support will be needed to achieve its goals. Seychelles is the only SIDS to commit to sharing knowledge gained with other States, to help build global understanding about blue carbon ecosystems.

#### 5.4. Governance matters

All States recognise the importance of governance in terms of institutions, laws and policies, although again their commitments vary. Having recognised the vulnerability and value of marine and coastal ecosystems, and their importance for nature-based adaptation and mitigation solutions to climate change, the question remains as to how the commitments made in the NDCs can be achieved. Clearly, on-the-ground action, as well as financial and technical resourcing is needed, but law, policy and governance also have a role to play. Table 7 sets out a summary of references to enhanced law, policy or governance arrangements. The summary focuses on improved or new arrangements, rather than highlighting existing laws, policies and institutions.

### 6. Analysis of findings

The above tables and findings demonstrate the strong commitment Indian Ocean SIDS have made to addressing climate change. All States have signed and ratified key international law instruments and have submitted NDC documents, most of which have been updated. This commitment to the global regime is vital, as political will to advance mitigation and adaptation options is essential for success.

All of the States explored here pledge valuable commitments, but these vary between nations and no two States have closely aligned NDCs. That is in keeping with the spirit of the Paris Agreement which encourages a nationally-based approach to climate change mitigation and adaptation options and activities. There are, however, some patterns in the commitments made. First, the risks to marine and coastal ecosystems are certainly appreciated by all these nations, and they have committed to enhanced conservation in one way or another. Secondly, all the SIDS include NbS for either adaptation or mitigation, or both. The commitments made appear to vary based upon the availability of baseline data and technical capacity. Some States refer to the need for more data before commitments can be made, whereas others have some information but note the need for further research and detailed mapping and inventories. For example, Seychelles has the most detailed NDC with respect to specific, quantified, goals and targets. Mauritius is also fairly well advanced in this respect. Seychelles has had the advantage of a World Bank study and marine protected area management developments facilitated by a debt swap and marine spatial plan initiative (<https://seymsp.com/>). Other nations are at a different point in the development spectrum, and have attracted less research attention, resulting in more limited data and capacity, which in turn has led to less sophisticated NDCs. Building capacity is vital and this can be done through the provision of financial and technical assistance from outside the region, but the particular geographies and vulnerabilities of SIDS require tailored solutions, and in that context, it is very heartening to see Seychelles explicitly commit to sharing its knowledge and lessons learned to assist other nations.

Thirdly, some States are more future-focused, committing to new governance initiatives: for example, Maldives, Mauritius and Seychelles. Other States, such as Singapore, do not focus on enhancements but rather reflect on early policy interventions. Of the more prospective NDCs, one feature is the commitment to developing or implementing a climate change policy or Act. Whilst this may be beneficial it could also lead to further siloing if climate change laws and policies develop separately from pre-existing wildlife and biodiversity conservation,

planning law and land use development policy. Nevertheless, it is encouraging to see that there are many references to integration, both in terms of embedding climate change in existing frameworks and ensuring marine and coastal conservation is built into new climate governance regimes. This is particularly evident in Maldives, Mauritius and Seychelles.

A further highlight is the commitment to integration which features in several NDCs. If maximum benefit is to be gained from interlinking biodiversity conservation and climate change, and streamlined laws and policies being advanced, then ways must be found to better integrate existing (and planned future) governance arrangements across and between sectors. The alternative is siloed responses which will place increased legal and administrative burdens on resource-poor SIDS. The NDCs do not, at this stage, include further detail about how greater integration will be achieved. Reference is made to developing whole-of-government approaches and cross-institutional frameworks, for example, but no further detail about the mechanisms to deliver on these commitments. Perhaps because of this there are no commitments to monitoring or evaluating integration to assess whether these goals are being achieved. Maldives does indicate it will mainstream climate change in public policies across other sectors but does not go so far as to commit to integrated legislation or institutional architecture. Mauritius commits to integration in response to fragmentation across scales of governance, but again no further detail is provided. The most explicit commitments come from the Seychelles – a policy burden evaluation and network of policy analysts – which may provide a basis and vehicle for advancing integrated policies across sectors. Again, there is a potential for greater leadership through the sharing of successes and failures as these commitments are implemented.

The findings of this desk-based study demonstrate that further research is needed across all of these jurisdictions, to unpack the commitments made and to monitor their implementation. For example, detailed analysis is needed within each State to better understand national institutional arrangements, laws and policies for marine and coastal conservation and climate change, the extent to which they already provide for integration, and options for enhancement. A broader analysis could also be undertaken of each Indian Ocean SIDS, by examining commitments under the CBD through NBSAPs, to analyse consistency with the NDCs, gaps and overlaps, as well as to explore areas for greater integration. Additionally, fieldwork and empirical analysis would provide valuable insights into the implementation of commitments on the ground, including institutional, legal and policy approaches to integration, in order to identify challenges that might hinder success. Further cross-regional analysis could support legal, technical and financial capacity building. There is, perhaps, a role for regional organisations in this regard, including the Indian Ocean Rim Association and Indian Ocean Commission.

### 7. Conclusion

This paper has explored Indian Ocean SIDS' commitments to NbS as a response to both climate change and marine and coastal biodiversity loss. The research has focused on an analysis of the NDCs, as all the case study countries have submitted these documents as part of their obligations under the Paris Agreement. In doing so this paper contributes to the growing body of work analysing mitigation and adaptation commitments made in NDCs, and thereafter, implementation of them. This research demonstrates that the Indian Ocean SIDS are actively engaged in marine and coastal conservation, and NbS to climate change, albeit to varying extents. Furthermore, it shows that there is no one-size-fits-all, even for similar small island nations facing many common challenges. The advantage of NDCs is that they allow for flexible approaches to the shared common challenge of climate change. Whilst adaptation features strongly as a national and local issue, in terms of mitigation, it will be the cumulative effect of all nations' actions that will prevent catastrophic change to Earth's climate and environment. From a biodiversity



conservation and adaptation perspective, commitments are expected to be more nationally-focused, and, in part, this can be seen from the above analysis. It is hoped that as awareness is raised about NbS, and evidence emerges of effective ways to turn the potential synergies into tangible co-benefits, commitments made in NDCs will evolve.

For Indian Ocean SIDS, this article provides only a first step in mapping and analysing the intersection of marine and coastal biodiversity conservation and climate change responses, as well as the extent to which NDC commitments are integrated in governance terms. Nevertheless, it is hoped that this provides a firm foundation for the further research. In addition, as the Indian Ocean SIDS progress with implementing their NDCs, there are likely to be success stories and failures, and much may be learnt from sharing knowledge and experiences. Similar analyses for other nations with common challenges and economies could also be a way to advance the international goals for climate mitigation and adaptation, as well as marine and coastal biodiversity conservation in the Indian Ocean SIDS. Facilitating cooperation and collaboration within, and beyond, the Indian Ocean SIDS will be crucial.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Data availability

No data was used for the research described in the article.

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