NATIONAL POLICY AND STRATEGIC ACTION PLAN ON CORAL REEF CONSERVATION AND MANAGEMENT

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Acronyms and Abbreviations

CBD:	Convention on Biological Diversity
CITES:	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COTS:	Crown of Thorns Starfish
EEZ:	Exclusive Economic Zone
EIA:	Environmental Impact Assessment
EMPS:	Environmental Management Plan for Seychelles
EPA:	Environment Protection Act
FAO:	United Nations Food and Agriculture Organization
GCRMN:	Global Coral Reef Monitoring Network
GoS:	Government of Seychelles
INDC:	Intended Nationally Determined Contribution
IUCN:	International Union for Conservation of Nature
MACCE:	Ministry of Agriculture, Climate Change and Environment
MLH:	Ministry of Lands and Housing
MoF:	Ministry of Fisheries
MSP:	Marine Spatial Plan
NBSAP:	National Biodiversity Strategy and Action Plan
NDS:	National development Strategy
NGO:	Non-Governmental Organisation
NPNCA:	National Parks and Nature Conservancy Act
NPOA:	National Plan of Action for the Conservation and Management of Sharks
NRC:	Nature Reserves and Conservancy
PA:	Protected Area
PAA:	Protected Area Act
SAA:	Sensitive Areas Atlas
SAP:	Strategy and Action Plan
SFA:	Seychelles Fisheries Authority
SMSA:	Seychelles maritime Safety Authority
SNPA:	Seychelles National Parks Authority
SOA:	Seychelles Ocean Authority
SPDF:	Seychelles Peoples Defence Forces
SST:	Sea Surface Temperatures
TCPA:	Town and Country Planning Act
WABPA:	Wild Animals and Birds Protection Act

Glossary

Adaptation: The process of change by which an organism or species becomes better suited to its environment

Biodiversity: The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Biomass: The total quantity or weight of organisms in a given area or volume.

Climate change: A change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

Coral: Any of a variety of invertebrate marine organisms of the class Anthozoa (phylum Cnidaria) that are characterized by skeletons—external or internal—of a stone-like, horny, or leathery consistency. The term coral is also applied to the skeletons of those animals, particularly to those of the stone-like corals.

Coral bleaching: The loss of colour from corals under stressful environmental conditions resulting from the expulsion of their zooxanthellae. The major causes are unusually high water temperature and light intensity.

Coral reef: An underwater ecosystem characterized by reef-building corals.

Coral reef degradation: The loss of quality of coral reef ecosystems and the ecological goods and services that they supply. Often related to death of corals and the loss of reef structural complexity and associated reef biodiversity.

Coral reef restoration: The process of assisting the recovery of a coral reef ecosystem that has been degraded, damaged, or destroyed.

Coastal zone: The interface between land and sea, defined as the part of the land affected by its proximity to the sea (influence of marine processes), and the part of the sea affected by its proximity to the land (influence of terrestrial processes).

Coral colony: A group of genetically identical coral polyps.

Coral refugia: Habitats which possess physical, biological and ecological characteristics that make the corals that occur there resilient to future climate change.

Ecosystem: A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

Ecological services: The many and varied benefits to humans provided by the natural environment and from healthy ecosystems.

Eco-region: A relatively large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions.

Genus (Plural genera): A principal taxonomic category that ranks above species and below family, and is denoted by a capitalized Latin name, e.g. Acropora.

Habitat: The natural home or environment of an animal, plant, or other organism.

Hard coral: Any of various anthozoans with a hard calcareous skeleton that contribute to reef building, especially one of the order Scleractinia.

Heterogeneity: The quality or state of consisting of dissimilar or diverse elements.

Mitigation: The action of reducing the severity, seriousness, or painfulness of something.

Monitoring: The process of observing and checking the progress or quality of (something) over a period of time through systematic data collection.

Phase-shift: The transition of an ecosystem from one stable state to another as a result of environmental perturbations.

Policy: A deliberate system of principles to guide decisions and achieve rational outcomes.

Population: A group of individuals that belong in the same species and live in the same area.

Recruitment: The process by which young individuals (e.g. fish and coral larvae, algae propagules) undergo larval settlement and become part of the adult population.

Reef flat: An extensive shallow area of the reef, bounded seaward by the reef crest (the crest being the transitional area between the flat and the upper reef slope), and leeward by the back reef

Reef slope: The outside part of a reef seaward of the reef crest (or reef edge) facing open sea.

Regime: A characteristic behaviour of a system which is maintained by mutually reinforced processes or feedbacks.

Seabed: The bottom of the ocean, no matter how deep. All floors of the ocean are known as seabeds.

Species abundance: The relative representation of a species in a particular ecosystem. It is usually measured as the number of individuals found per sample.

Soft coral: Any of various anthozoans of the subclass Octocorallia, such as the sea fans, which have polyps with eight feathery tentacles and typically a flexible skeleton.

Strategic Action plan: A plan for transforming strategies into on the ground actions to achieve set goals and objectives.

Stressor: A chemical or biological agent, environmental condition, external stimulus or an event seen as causing stress to an organism.

Zooxanthellae: A colloquial term for single-celled dinoflagellates that are able to live in symbiosis with diverse marine invertebrates including demosponges, corals, jellyfish, and nudibranchs.

Process

This document was prepared for the Government of Seychelles with funding from the IBRD "Third South West Indian Ocean Fisheries Governance and Shared Growth Project (SWIOFish3). The policy and strategic action plan were produced through an iterative process of national stakeholder consultation.

The process was initiated by reviews of the status of, and national governance framework for, coral reefs in Seychelles. International best practice in coral reef policy and management, in particular with regard to the impacts of climate change was also investigated. National coral reef stakeholders interviewed in person and virtually using a standardised questionnaire to ascertain the concerns, perceptions and opinions of stakeholders with regard to coral reefs, their utility, the threats they face and their management. These reviews were then utilised to draft a framework Strategic Action Plan (SAP). The scope of the framework SAP was determined by using the coverage of the International Coral Reef Initiative (ICRI) Plan of Action 2018-2020 and the Convention on Biological Diversity decision COP XII/23 Annex (Priority Actions to Achieve Aichi Biodiversity Target 10 for Coral Reefs) as templates.

The first national stakeholder workshop was held on the 28th August 2020 at the International Conference Centre (ICCS). Presentations were given on the status and trends of, and the governance framework for, coral reefs in Seychelles; and the findings and analysis of the national stakeholder questionnaire. The framework SAP was then presented and stakeholders divided into working groups to discuss, amend and elaborate it as they saw fit. The results of this workshop were compiled into the SAP format with modified logical framework structure: Mission Statement, Objectives leading to Work Programmes, duration Monitoring and review.

A policy text was then drafted and both it and the draft SAP circulated to stakeholders prior to the second national stakeholder workshop which took place on the 16th December 2020 again at the ICCS.

The workshop reviewed and finalised the SAP and worked extensively on the draft policy seeking further details and the elaboration and addition of specific enumerated Policy Statements. The findings and requests of stakeholders were followed in the finalisation of the SAP and elaboration of the Policy text. These were then circulated to stakeholders for final comments and approval.

Document Structure

For ease of access to and ready assimilation of the active components of this document the Seychelles Coral Reef Policy and Strategic Action Plan are situated at the beginning of the document. For those interested in the background for the policy and action plan, the status of coral reefs and a situation analysis of coral reef governance in Seychelles are presented in subsequent sections.

Implementation Framework

The primary and overarching national strategic document for Biodiversity is the Seychelles National Biodiversity Strategy and Action Plan (NBSAP). The following Policy and Strategic Action Plan should therefore be seen in the context of the strategic goals of the NBSAP and its Operational Principles namely that it should be implemented within operating principles as enshrined in the text and key decisions of the Convention on Biological Diversity (CBD). Central tenets that are fundamental to sound implementation are:

The Precautionary Principle

Intrinsic Value

The Ecosystem Approach / Ecologically Sustainable Development

The Interdependence of Humans and Biodiversity

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Seychelles' Coral Reef Policy

This Policy document has been developed, through an iterative process of national stakeholder consultation, to support the attainment of the Seychelles Vision for Coral Reefs.

Vision

Seychelles' coral reefs and associated ecosystems are effectively conserved and adaptively managed to improve resilience and allow for the sustainable provision of key ecosystem, economic and social services

The Importance of Coral Reefs

Seychelles recognises the great biological, social, economic and environmental importance of coral reefs.

Coral reefs are the most biodiverse of marine ecosystems, providing habitat for a significant proportion of the world's marine species.

They provide, often critical, habitats for commercially important species that support livelihoods, contribute to poverty alleviation and provide vital food security to the local population.
They harbour threatened and iconic species which provide the basis for dive tourism and other eco-related marine activities.

Fringing reefs also provide physical services such as buffering against storm surges and protecting coastlines against erosion.

Finally coral reefs are of cultural importance to Seychelles having played, and continuing to play, a significant role in shaping the national way of life and contributing in diverse ways to individual wellbeing.

Threats to Coral Reefs

Seychelles furthermore recognises that coral reefs are at risk and experiencing multiple, often synergistic, stressors that threaten their integrity, productivity, service provision and future existence. The 1998 extreme coral bleaching event in Seychelles brought home the devastating impact of high sea water temperatures on coral reefs and the primary underlying role of climate change therein. Up to 90% of live coral cover was lost in the central archipelago and subsequent surveys indicate that more than 40% of these reefs shifted permanently to algal dominated habitats. Subsequent bleaching events

have further hampered coral recovery. Acidification of the ocean and increasing water temperature is expected to lead to more intense and frequent coral bleaching events. The degradation of near-shore coral reefs is expected to result in reduced reef height and result in pseudo-sea level rise which would further exacerbate coastal erosion.

The widest-ranging and key direct anthropogenic stressor to Seychelles' coral reefs has been identified as overfishing (GoS 2014a). Coral reefs fringing and close to developed islands experience a suite of additional factors such as siltation, nutrient enrichment and chemical pollution from terrestrial run-off and direct physical damage including: reclamation, creation and maintenance of navigation channels, vessel and anchor damage and reef gleaning activities.

Requirement for an Integrated National Strategic Approach to Coral Reef Management

The coral reef management scenario is complex and requires a comprehensive and integrated strategic approach to address diverse factors. Coral reefs form part of the broader natural environment and cannot be addressed in isolation. In particular they are often closely and functionally associated with other marine ecosystems. Consequently it can be appropriate to develop integrated ecosystem management approaches that address them together i.e. in a manner analgous the national Ridge to Reef initiative, which seeks to manage mountaintop to fringing reef in an integrated and holistic manner around the principal granite islands.

As party to both the United Nations Framework Convention on Climate Change and its Paris Agreement, Seychelles is addressing its national Green House Gas (GHG) emissions through its Nationally Determined Contribution (GoS 2015). Seychelles' GHG emissions however constitute less than 0.003% of global emissions and as such any reduction measures it may take will have very limited impact on global climate trends. However, as an oceanic small island developing state, the Seychelles is highly vulnerable to climate change and will need to adapt to its effects. This is already being integrated in the policy landscape. The Seychelles National Climate Change Policy seeks to mainstream and integrate climate change considerations into all relevant sectors and aims to put in place measures to adapt, build resilience and minimize vulnerability to the impacts of climate change.

Accordingly, the new Nationally Determined Contribution for climate change is expected to have a stronger focus on blue carbon ecosystems and their role in mitigating and adapting to climate change. In the context of the conservation and sustainable use of Seychelles' coral reefs it is clear therefore, that it is action to reduce local, direct anthropogenic stressors that offers the best scope for beneficial change. At certain locations, coral reefs could also benefit from ecosystem restoration actions and other human-assisted measures that promote greater resilience.

Policy Statements

The policy statements outlined below provide a structured approach to the management of Seychelles' coral reefs and the reduction of the cumulative impacts of different natural and anthropogenic stressors. The policies were developed through a consultation with national stakeholders and are supported by the Strategic Action Plan (SAP) that identifies and prioritises actions that contribute to the overall vision of the National Coral Reef Policy.

Policy Statement 1: Coral Reef Governance

The Seychelles marine governance structure is broad and complex. Coral reefs, habitats of critical ecological, economic and social importance, are recognised as being under represented in the Seychelles' governance context in terms of a targeted approach to administration and legal protection[1]. A specific mechanism[2] for the national approach to coral reef conservation, sustainable use and research coupled with legislation protecting coral will therefore be established and maintained.

Policy Statement 2: Coordination of the National Strategic Approach to Coral Reef Management.

Coordination of strategic approaches to environmental management have been identified as an institutional weakness. The Seychelles Coral Strategy and Action Plan will adopt a new approach to address this shortcoming. The Steering Committee (SAP SC) will be constituted under the Environment Protection Act (2016). The Steering Committee will be balanced and representative in membership and equitable and transparent in its mode of operation. The SAP SC will be empowered under paragraph 9 of the EPA (2016) to require the attendance and the appropriate reporting from agencies in line with their role and the provisions and activities of the SAP. The role of SAP SC Secretariat will be funded by Government and tendered out under contract to ensure the efficient and cost-effective provision of support to the operations of the SAP SC.

[1]The designation of the 32.6% of Seychelles' waters under the Marine Spatial Plan implies protection of the 5.7% of coral reefs that lie within Zone 1 and provides potential for protection of the 79.3% of coral that lies in zone 2. At the time of writing however provisions have yet to be elaborated in that regard.

[2]This refers to the Seychelles Coral Reef Strategic Action Plan which accompanies this Policy.

Policy Statement 3: Inclusion and the Implementation of the National Coral Reef Strategy and Action Plan.

Coral reefs are of societal importance and the issues they face are diverse and cross-cutting. Broad stakeholder input and activity is therefore central to the effective implementation of the SAP and will be fostered and facilitated as much as practicable. The Ministry responsible for Environment will be the lead agency in the implementation of the National Coral Reef Policy and SAP.

Policy Statement 4: Coral Reefs throughout Seychelles.

The Coral SAP is intended to cover all reef building corals and coral reef habitats from fringing reefs to deep water coral formations. The majority of known coral reefs in Seychelles occur on the banks of the sparsely populated outer islands. Coral reefs proximate to the main populated islands are exposed to far greater land based stressors however, than the outer islands, due to the direct impact of human activity and the topography of the granitic islands. Fishing pressure on reefs also attenuates with distance from the main populated islands. The focus of activities to address land-based stressors will therefore be around the main granite islands. This should in no way be interpreted as placing greater importance on the reefs of the inner islands but rather that it reflects the differing circumstances of the various island groups.

Policy Statement 5: Coral Reef Research and Monitoring

Coral reef research and scientific monitoring is fundamental to the successful implementation of the SAP. Research should be management-oriented addressing, as a priority, the key knowledge gaps that limit the development, implementation and efficacy of national and local management measures to enhance the resilience, conservation and sustainable use of coral reefs. Monitoring activities must meet the minimum criteria for utility established under the SAP to receive support from the SAP process and mechanism. The Government and the SAP SC will focus on the facilitating of finance for, and the effective dissemination and application of the findings of, coral reef research and monitoring.

Policy Statement 6: Coral Reef Refugia

Coral reef refugia, i.e. climate change thermal-stress refugia for reef corals whether that be due to the physical properties of the location or the genetic make-up of the corals, have been identified as a key component to the national approach to the conservation and sustainable use of coral reefs in Seychelles. A number of apparent coral refugia have been documented in Seychelles to date. Refugia foster the persistence and resilience of biodiversity in the context of anthropogenic climate change. There should therefore be a focus on the identification and protection of coral refugia.

Policy Statement 7: Valuation of Coral Reef Ecosystems (Goods and Services)

Empirical information on the value of coral reef ecosystem goods and services is essential for informed decision-making. Government will promote the structured economic valuation of coral reefs and incorporate the findings into national accounting and decision-making mechanisms. Government will also support the development of a business case for investments in nature-based solutions and identification of monetizable benefits that can be used for sustainable financing. In cases when information is lacking the precautionary principle will be used. Decision-making will also incorporate consideration of non-use and intrinsic values of coral reef ecosystems.

Policy Statement 8: Fishery Management and Limits of Acceptable Change

Recent fish stock assessments by the Seychelles Fishing Authority have shown that many commercially targeted reef-associated fish species are currently over-fished and undergoing over fishing. The excessive removal of certain fish species or trophic groups from coral reefs can lead to trophic cascades and dramatic deterioration of the ecosystem. Government will support an integrated ecosystem approach to fishery management (EAFM) through implementation of the 2019 Fishery Policy; and by targeted measures for coral reef ecosystem management such as the reduction of fishing pressure on keystone species and groups and the identification of Limits of Acceptable Change in fish biomass and species diversity on coral reefs.

Policy Statement 9: Land-based Stressors and Ambient Environmental Quality Monitoring

Coral reefs require good water quality to develop well and remain healthy. Land-based stressors reduce water quality and are of significant impact in the near shore coral reef environments of the main granitic islands. Many, if not all, of these stressors could be significantly mitigated by effective integrated land management approaches in line with Seychelles' commitments under the Nairobi Convention. Seychelles already has the governance mechanisms to address these issues – the Development Management Cycle, Planning Authority and associated legislation such as the Town and Country Planning Act and the Environment Protection Act. There should therefore be a concerted effort to improve enforcement of existing regulations and related capacity building. Furthermore to support any such undertaking there should be a re-initiation of a structured and representative approach to the monitoring of, and the maintenance of a national database on, ambient environmental quality which will enable the ready identification of chronic problem areas and the adaptive management of corrective measures.

Policy Statement 10: Reducing physical alteration and destruction of coral reef ecosystems.

The main causes of physical damage to coral reefs in Seychelles are: dredging and reclamation, anchor damage, vessel groundings, the opening of reef channels and trampling by reef users. Over the last 50 years large areas of reef, particularly along the East coast of Mahé, have been dredged and reclaimed for development at the expense of marine biodiversity including critical habitats. Years later adjacent reefs continue to be smothered by soft sediments created by the dredging. The development of the marine tourism industry, particularly yachting tourism, has increased human interaction with coral reefs and the lack of appropriate mooring buoys has exacerbated damage to coral reefs. Government commits to reducing damage to reefs by ensuring the full application of the Environment Protection Act and its EIA regulations for development proposals and regulating the protection of corals. Government will furthermore encourage and facilitate the installation of mooring buoys where necessary and the creation of a legal framework for users to pay for such facilities.

Policy Statement 11: Coral reef restoration/rehabilitation.

Coral reef restoration is now an accepted component of the coral reef conservation and management toolkit. At certain locations in the Seychelles, coral reef restoration/ rehabilitation pilot projects have been undertaken with the objective of restoring ecological goods and services. The Government will actively encourage and support the restoration of degraded coral reef sites. The focus should be on restoration of ecological services, especially in areas of high socio-economic value and in areas where such interventions could help with the protection of shorelines. Ecological restoration will be the primary focus, however, the piloting of physical restoration techniques such as “blue barriers” will also be encouraged. Other human-assisted coral reef restoration techniques such as rubble bed stabilisation and macro-algae control will also be fostered. All coral reef restoration projects will however need to be approved by the Ministry responsible for Environment.

Policy Statement 12: Sustainable Financing

The management and protection of coral reefs has historically been restricted to a few relatively small Protected Areas and otherwise severely under-funded in Seychelles. The majority of coral research has been funded by international donors and much ongoing monitoring is driven by international agencies. The national approach to coral reef management has changed dramatically with the designation of over 32% of Seychelles’ territorial and EEZ waters as protected under the Marine Spatial Plan initiative. It is estimated that 85% of Seychelles known coral reefs are included within these areas (Zone 1: 5.7% and Zone 2: 79.3%). The 2018 BIOFIN Seychelles Biodiversity Expenditure Review noted that biodiversity related revenue from the two main economic sectors, tourism and fisheries, was not being sufficiently reinvested into biodiversity

management. The subsequent Biodiversity Finance Plan (BFP) presented a coherent and comprehensive national approach to biodiversity finance, which offers a good framework for the elaboration of sustainable financing mechanisms for coral reefs. The BFP should be implemented and business cases made for the conservation of coral reefs and appropriate sustainable financing schemes established for the representative monitoring, management, conservation, restoration (where appropriate) and sustainable use of coral reefs and associated biodiversity in Seychelles.

Policy Statement 13: Public Engagement, Education and Awareness

Environmental management is ultimately the management of people and their activities. Public engagement, education and awareness is thus the corner stone of environmental management. Reducing human impact on coral reefs is essential if reefs are to be resilient and adaptable to the impacts of climate change. Providing the public, visitors and policy makers the information they need to behave, act and operate appropriately to optimise coral reef health and resilience is therefore a fundamental precursor to the successful implementation of the Coral SAP. To that end a comprehensive public education and awareness campaign will be developed and implemented with elements targeting various key segments of society to enable their informed decision-making relative to and their inclusion and involvement, as appropriate, in the conservation and sustainable use of Seychelles' coral reefs. Efforts will include integrating a coral reef component in environmental education throughout all levels of the school curriculum. Seychelles' coral reefs and reef-based tourism activities will be promoted with the aim of generating nature-based added value in the national tourism product.

A national strategic approach to coral reef management must bring together and build upon the diverse governance mechanisms already in place to reduce stress and impacts upon coral reefs (e.g. the development management cycle through the Planning Authority and related legislation – the Town and Country Planning Act, the Environment Protection Act and its EIA Regulations, the Fisheries Act, the National Parks and Nature Conservancy Act, the State Lands and River Reserves Act etc…) and seek to facilitate the development and implementation of, and optimally utilise, new national initiatives such as the Marine Spatial Plan, the Mahé plateau trap and line fishery co-management plan, the fisheries sector policy and strategy, the national ridge to reef project etc…

To that end the Government of Seychelles, in partnership with national coral reef stakeholders, undertook to develop, through an iterative process of stakeholder consultation, the following Policy statements and ***Seychelles Coral Reef Strategy and Action Plan.***

[3] Priority Actions to Achieve Aichi Biodiversity Target 10 for Coral Reefs and Closely Associated Ecosystems.

This document, with particular reference to the Annex[3] to CBD COP Decision XII/23 and the ICRI strategic Plan 2018-2020, sets out the agreed priority national actions to support Seychelles implementation of:

- Aichi Biodiversity Target 10: the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

- Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

It sets out a Vision for Seychelles' coral reefs with a Mission Statement and key objectives supported by dedicated work programmes all set in the context of best practice modus operandi and Operational Principles.

Seychelles Coral Reef Strategic Action Plan

"To this end, Parties should develop national coral reef action strategies, or equivalent policies, strategies, plans or programmes, consolidating existing national initiatives, as platforms to mobilize inter-agency and cross-sectoral partnerships, as well as close coordination among national and subnational governments and with indigenous and local communities."

Convention on Biological Diversity Decision COP XII/23. Annex

Mission

The Governance structure and national strategic approach are in place and financed. The technical science-based tools and capacities for the effective conservation, adaptive management and sustainable use of Seychelles' coral reefs[4] are established and under implementation.

Objectives

1. Establish an effective, transparent and equitable governance structure for coral and coral reef protection, conservation, sustainable use, and adaptive management[5].

2. Minimise local and national anthropogenic stressors on, and build resilience of coral reefs.

3. Undertake management oriented monitoring and research of coral reef ecosystems.

4. Mainstream coral reef financing, conservation and sustainable use.

5. Build public and stakeholder awareness of, and engagement in activities to address, the value, importance and vulnerability of coral reef ecosystems.

Duration, Monitoring and Review

The Coral SAP is intended to have a 5-year duration, 2021-2025. Monitoring will be undertaken by the SAP Steering Committee and will assess implementation of objectives through the attainment of Work Programme results. A mid-term review should be undertaken after 3 years to assess progress and identify issues to be addressed in order to optimise implementation by the end of year 5. The Steering Committee will organise for an independent review in year 5 and the development of the next iteration of the plan.

[4] Wherever the term "coral reef" is utilised unless the context of the text indicates otherwise it should be interpreted as including the appropriate consideration of "associated ecosystems".

[5] Including reef restoration/rehabilitation where appropriate.

Work Programme 1	**Establish an effective, transparent and equitable governance structure for coral and coral reef protection, conservation, sustainable use, and adaptive management.**

Situation Analysis. Over the last 10 years Seychelles' implementation of national strategic documents in the environmental domain has proven problematic (e.g. SSDS, NBSAP) due to a lack of institutional capacity to properly run the secretariat and coordinate national implementation. Stakeholders identified this as a matter of key concern in the Coral SAP national workshop and a distinct consultation group was formed to specifically address this issue. The outcome of the stakeholders' deliberations are set out in the Governance mechanism note below.

Targeted protection of coral and coral reefs outside of specific existing MPAs in Seychelles is very limited. Perhaps the most significant measures being the regulations that prohibit demersal trawling and the use of poisons and explosives.

Activity		Priority (1-3)	Time line	Agencies[6] /Notes
1.1	Establish representative and transparent SAP steering mechanism.	1	2021	
	1.1.1. Identify Steering Committee (SAP SC) membership.	1	2021	MACCE & stakeholders
	1.1.2. Develop SAP SC terms of reference and modus operandi.	1	2021	SAP SC
	1.1.3. Role of SAP SC secretariat to be tendered out.	1	2021	MACCE, SAP SC.
1.2	Ensure effective liaison and cooperation with national agencies and actors with responsibilities relevant to the conservation and sustainable use of coral and coral reefs in Seychelles.	1	2021-25	
	1.2.1. Regulate SAP SC under EPA so that it can require appropriate attendance and reporting on implementation by Government agencies etc...	1	end 2021	MACCE, SAP SC, AG's Office
	1.2.2. SAP SC meets regularly and functions in line with mandate and modus operandi to implement SAP.	1	2021	SAP SC MACCE
	1.2.3. Work with appropriate agencies to ensure coral reefs are mainstreamed into MSP MPA management plans **(X-ref 2.3.2)**.	1	onwards	SAP SC, MACCE, TNC, SOA
1.3	Develop and promulgate regulations to specifically protect coral and coral reefs.	1	2021-22	MACCE, SAP SC, AG's Office Align with MSP

[6]The identification of agencies is intended as a guideline, it is not intended to be a restrictive or mandatory list.

Results		Indicators
1.1	1.1.1. Representative SAP SC formed.	SAP SC membership Minutes of meetings.
	1.1.2. SAP SC Objectives and modus operandi established and documented.	Minutes of meetings.
	1.1.3. SAP SC secretariat functions in efficient and cost-effective manner.	Tender bids, Secretariat budget, SAP SC minutes, assessment reports.
1.2	1.2.1. SAP SC promulgated under EPA.	Official Gazette
	1.2.2. SAP SC meets regularly with implementing agencies attending and reporting on implementation, as required.	Minutes of meetings Government agency and Stakeholder implementation reports.
	1.2.3. MSP and MPA management plans reflect importance of Coral reefs in their content, activities and outputs.	MPA management Plans.
1.3	Develop and promulgate regulations to specifically protect coral and coral reefs.	Official Gazette

Governance Mechanism Note:
The Coral SAP Steering Committee (SAP SC) should be regulated under the Environment Protection Act 2016 as a distinct agency utilising Paragraphs 9 & 10. The SAP SC will be empowered under Paragraph 9 to require appropriate Government agencies attendance at, and compliance in reporting on implementation to, the SAP SC in line with the provisions and activities of the SAP. This requirement being necessary as it was seen to have been a key limiting factor in the implementation of the Environment Management Plan of Seychelles 2000-2010.

The SAP SC Secretariat to be funded by Government with the role to be tendered out.

Work Programme 2	**Minimise local and national anthropogenic stressors on and build resilience of coral reefs and associated marine ecosystems.**

Situation Analysis. In the context of direct anthropogenic stressors there are two distinct scenarios in Seychelles. The inner reefs (i.e. fringing reefs and nearshore coral formations) around the populated islands of Mahe, Praslin, La Digue and Silhouette are exposed to diverse and often intensive land-based pressures. All other reefs experience relatively little to no land-based stressors. Fishing pressure is widespread throughout the Seychelles with some attenuation of effort on the Mahé plateau the further reefs are from the populated islands, and the southern islands are exposed to less effort than the Mahé plateau.

Land-based stressors include siltation, pollution (nutrient enrichment and chemical pollution) and physical damage such as reclamation, dredging, creation of channels, harvesting and other direct human activity, vessels and anchor damage etc...

This work programme has a very broad scope and so is divided into three components: 1) Reduction of fishing pressure, 2) Minimisation of land-based stressors, and 3) Augment coral reef resilience.

Activity		Priority (1-3)	Time line	Agencies/Notes
2.1	Reduce fishing pressure in general and in particular on keystone coral reef species/groups.			
	2.1.1. Identify keystone species/groups for fishery management.	1	2021-22	SAP SC, SFA, MACCE.
	2.1.2. Review and revise regulations on fishing gear, catch limits, management thresholds **(X-ref 3.2)**, keystone species/groups.	2	2022-25	SFA, Fishery Committee, SAP SC.
	2.1.3. Review enforcement mechanisms[7], establish clear zones of responsibility, chain of command, and foster community involvement.	1	2021	SAP SC, SFA, SNPA
	2.1.4. Strengthen capacity and protocols for enforcement.	1	2021-25	SAP SC, SFA/MoF, MACCE, SNPA.
	2.1.5. Undertake review of marine curio trade and market with a view to phasing it out.	2	2023	MACCE, SFA.
2.2	Minimise land-based stressors			
	2.2.1. Promote coral reef consideration in Coastal Zone Management and existing development management processes and initiatives.	2	2021-25	MLH, Planning Authority, UNDP PCU R2R Project, MACCE.

[7] Investigate linking of enforcement to provision of concessions/subsidies, licenses.

	2.2.2. Treat coastal coral reefs as an integral unit with associated shallow marine ecosystems (e.g. mangroves, seagrasses).	1	2023	Planning Authority, R2R Project, MACCE.
	2.2.3. Lobby for and support ambient environmental quality monitoring (river nutrient loads, chemical inputs, sedimentation events)[8].	2	2021-25	SAP SC, MACCE, R2R project, SAA.
	2.2.4. Investigate scope for decentralised/local community management of reef areas.	2	2021-25	X-ref with WP 6
	2.2.5. Identify pilot community management areas/projects.	2	2021-25	Also partner with dive centres, charter operators, Fishery Assocs, PA management agencies.
	2.2.6. Identify anchoring areas appropriate to vessel size where mooring buoys are not feasible.	2	2022-24	SAP SC, SMSA, SPA, PA management agencies, vessel owners and charter companies.
2.3	Augment coral reef resilience **(X-ref 4.3.2)**			
	2.3.1. Identify priority areas for coral refugia and KBAs.	1	2021	SAP SC, MACCE, TNC.
	2.3.2. Ensure coral and coral reef issues and priorities, including protection of coral refugia[9] and Key Biodiversity Areas (KBAs), are properly incorporated in to the MSP & MPA management plans **(X-ref 1.2.3)**	1	2021-25	SAP SC, TNC, MACCE, SFA.
	2.3.3. Seek to undertake climate modelling to inform selection of coral refugia for protection and rehabilitation sites.	2	2022-25	MACCE, SMA
	2.3.4. Further develop, and investigate scope for expansion of, reef restoration projects including inter alia identification and propagation of temperature resistant corals.	2	2021-25	SAP SC, ENGOs, MACCE, private sector[10] .

[8] MACCE formerly undertook such a role utilising a mobile laboratory but no longer retains the needed capacity.
[9] Graham et al (2015) found that corals in Seychelles below a depth of 6m showed much higher resilience to bleaching events.
[10] Hotels, Dive centres, Charter operators.

Results		Indicators
2.1	Fishing pressure on coral reef keystone species reduced.	
	2.1.1. Keystone species identified with management recommendations.	Keystone species report(s) and recommendations.
	2.1.2. Regulations pertaining to keystone species and management thresholds promulgated **(X-ref 3.2).**	National Gazette.
	2.1.3 & 2.1.4. Fishery monitoring, control and surveillance enhanced.	Catch data. Reef survey data. Monitoring protocol and records. Cases prosecuted.
	2.1.5. Process for phasing out marine curio trade identified and, if appropriate, under implementation.	Curio trade report and recommendations.
2.2	Land-based sources of stress to coral reefs are reduced.	
	2.2.1 & 2.2.2. Coral reef issues prominent in management of development cycle.	EIA scoping reports. Planning Authority decisions and conditions. EPA 2016 ICZM provisions utilised.
	2.2.3. Representative scheme of ambient environmental quality monitoring (re)initiated.	Environment quality baseline established. Decline in frequency and severity of pollution and siltation events.
	2.2.4 & 2.2.5. Local community managed area pilot project(s) under implementation.	Implementation reports.
	2.2.6. Anchorages identified and regulated.	National Gazette and related maps.
2.3	Coral reef resilience enhanced.	
	2.3.1. Keystone species populations on reefs increased.	Reef survey data.
	2.3.1, 2.3.2 & 2.3.3. Proposals for revision of MSP include coral refugia and KBAs.	**Strategic approach to expansion of MPA network on Mahé Plateau developed.** MSP Mahe plateau zonation.
	2.3.4. Coral propagation and reef restoration projects are expanded, propagation and "out planting" of temperature resistant corals is ongoing and scope for cost-effective "upscaling" is assessed.	Coral propagation project reports. Recommendations for future coral propagation and reef restoration. No of projects. Area of reef re-planted.

Work Programme 3	**Undertake management oriented monitoring and research of coral reef ecosystems.**

Situation Analysis. Significant coral reef monitoring and research has been undertaken in Seychelles over the years and in particular since the 1990s and the coral bleaching event of 1998. Various local agencies undertake standardised reef monitoring and Seychelles contributes to the periodic CORDIO status reports. Several international scientists and universities have undertaken and/or maintain research programmes in Seychelles.

This wealth of information and future monitoring efforts need to be presented and developed respectively, to support reef management and decision-making processes. The development of a clear reef quality scoring and mapping regime would enable informed decision-making and engender stakeholder understanding and involvement in coral reef conservation and sustainable use initiatives.

The Caribbean Healthy Reefs Initiative has developed an excellent model in this regard that could be tailored to the Seychelles context (Kramer et al 2015, McField et al 2018).

Activity		Priority (1-3)	Time line	Agencies/Notes
3.1	Build capacity for national coral reef monitoring, data gathering, management and reporting.			
	3.1.1. Standardise national coral reef monitoring and reporting.	1	2021	MACCE, SAP SC, reef monitoring agencies
	3.1.2. Promote, as appropriate, citizen science monitoring, including integration of fishers, divers and boat charters.	2	2022-25	SAP SC.
3.2.	Identify thresholds (Limits of Acceptable Change -LAC) for reef fish biomass and diversity that trigger fishery management measures in MSP Zone 2 Areas and elsewhere as appropriate **(X-ref 2.1.2).**	2	2022 onwards	SPA SC, SFA, MACCE, research Agencies.
3.3	Develop score card system[11] and periodic report on reef health in Seychelles to support decision-making and enable adaptive management.	2	2022 onwards	SAP SC, MACCE, ENGOs.
3.4	Develop economic valuation[12] of reef categories (value per Ha).	2	2022-23	NGOs, Finance (MoFEPT), MACCE
3.5	Develop prioritised, targeted, management-oriented coral and coral reef research agenda.	1	2021	SAP SC, NISTI.

[11] The Caribbean Healthy Reefs Initiative (Kramer et al 2015, McField et al 2018) is an excellent model that could be tailored to the Seychelles context.
[12] To optimise coral reef consideration under existing national initiatives e.g. BERI, SeyCCAT.

3.6	Monitor Natural Stressors			
	3.6.1. Monitoring, assessment and reporting of "natural" stressors e.g.: COTS outbreaks, algal blooms, coral bleaching events etc…	2	2021 onwards	MACCE, SFA, PA management
	3.6.2. Develop, if and as appropriate, National Response Plan			agencies, research agencies.

Results		Indicators
3.1	Capacity developed for gathering, managing, presenting and utilising coral reef data.	National coral reef database established, populated and maintained.
	3.1.1. Stakeholder agreed national coral monitoring protocol.	Standardised coral monitoring methodology. National coral reef database.
	3.1.2. Data collection optimised.	Amount, quality and representative nature of data gathered improved.
3.2	Threshold indicators for fishery management measures (LAC) established for MSP Zone 2 areas and elsewhere as appropriate (X-ref 2.1.2).	Fish biomass and species diversity indicators, trigger and related management mechanisms.
3.3	Reef health score card system established and reef status and trends reported on.	Biennial reef health reports – with local and national reef health communicated effectively to decision-makers and the general public (X-ref WP 5).
3.4	Coral reef valuation and accounting enabled.	Coral reef types and quality classifications valued. Status and trends in reef value and economic contribution incorporated into reporting (X-ref Activity 3.3).
3.5	Management-oriented and prioritised National Coral Research Agenda established and under implementation.	National Coral Reef Research Agenda published. Implementation reports. Review report.
3.6	3.6.1. Natural stressor database established and trends (if present) identified.	Database. Stressor outbreak reports.
	3.6.2. Natural Stressor response/mitigation plans, as appropriate.	Plan documents.

Work Programme 4	**Mainstream coral reef financing, conservation and sustainable use.**

Situation Analysis. Coral reefs as an ecosystem, relative to their importance in the national context, have received little targeted investment over the years for their conservation and sustainable use. This is highlighted by: the lack of specific legal protection the ecosystem has received to date, the absence of reef services valuation and its incorporation into national accounting.

The national and international options for accessing funds to support coral reef conservation and sustainable use need to be reviewed and new and additional funds identified and accessed.

Activity		Priority (1-3)	Time line	Agencies/Notes
4.1	Incorporate value of coral and coral reef ecosystem and services into development management cycle, national accounting and other pertinent national decision-making mechanisms (X-ref Activity 3.3).			
	4.1.1. Undertake review and valuation of current commercial coral reef related activities (X-ref Activity 3.3).	1	2022-23	SAP SC, Finance (MoFEPT), MACCE, NGOs.
	4.1.2. Incorporate values into pertinent national decision-making mechanisms.	1	2024 onwards	SAP SC, Finance (MoFEPT), MACCE.
4.2	Identify and access new and additional sources of funding for coral reef management, restoration, monitoring and research.			
	4.2.1. Establish/identify new/existing trust fund for the receipt, management and disbursement of funds for coral reefs.	1	2021	SAP SC, Finance (MoFEPT), MACCE.
	4.2.2. Review existing national and international funding options and assessments (e.g. BioFin report etc...).	2	2022-23	SOA, MACCE
	4.2.3. Identify taxes levied from coral reef related commercial activities and assess scope for redirecting revenue to coral reef conservation and management (X-ref 4.1.1). (e.g. licensing fees for charters, fishers and tourism via appropriate trust fund mechanism).	2	2023	SAP SC, Finance (MoFEPT), MACCE.
	4.2.4. Strengthen environmental law enforcement and fines, especially for areas outside MPAs, with revenue to dedicated trust fund. (e.g. development and utilisation of spot fining mechanism for littering etc...)	2	2023-25	MACCE, SFA, SMSA, PA management agencies, Police.

4.3	Optimise coral reef non-consumptive and consumptive sustainable use and service provision.			
	4.3.1. Investigate and identify scope for expansion of sustainable revenue from coral reefs.	3	2023-25	MACCE, MPAs, NGOs, Private sector e.g. Proposed Mooring programme (X-ref 4.4)
	4.3.2. Undertake pilot Blue Barrier project(s) to promote coastal protection and reef resilience.	2	2021-23	MACCE, IBRD. e.g. North East Point.
	4.3.3. Investigate and identify non-sustainable coral reef related activities for phasing out. (X-ref: Activity 2.1.5)	3	2023-25	MACCE
4.4	Moorings programme			
	4.4.1. Identify areas for mooring installation.	2	2021	MACCE, SPA, SMSA, Charter boat operators, MPA management agencies
	4.4.2. Develop regulations to support moorings installation, fee collection and maintenance, especially for areas outside MPAs. (e.g. Cashless transaction for fees payment)	2	2022	
	4.4.3. Investigate and develop partnership agreements for the installation and maintenance of the mooring buoys.	1	2022	

Results		Indicators
4.1	Status and trends of reef and reef-services value is estimated, monitored and incorporated into national accounting.	Reef status and valuation reports.
4.2	4.2.1. Coral reef trust fund mechanism established. New and additional local and international funds for coral reef management are accessed.	Trust Fund accounts. Funding to coral reef research, management, conservation and sustainable use is increasing.
	4.2.2. & 4.2.3. Coral reef financing options assessed.	Financing options report and recommendations.
	4.2.4. Regulations are reviewed, spot fine options incorporated/optimised and enforcement stepped up.	Official Gazette. Revenues to coral reef trust fund mechanism
	4.2.5. Recommendations for coral reef levy options presented.	Report Document.

4.3	Sustainable revenues from coral reefs diversified and increased.	National accounts. Trust fund income. Reef status scoring.
	4.3.1. Proposals for diversified reef sustainable related activities.	Report
	4.3.2. Blue Barrier pilot projects under implementation, monitoring and evaluation.	Implementation reports. Maps, GIS layer.
	4.3.3. Unsustainable coral reef related activities identified.	Report with recommendations for phasing out unsustainable activities.
4.4	Mooring installation and maintenance governance framework established.	Official Gazette. Number of moorings under operation.

Work Programme 5	**Build public and stakeholder awareness of, and engagement in activities to address, the value, importance and vulnerability of coral reef ecosystems.**

Situation Analysis. To engender broad stakeholder interest and involvement, provide a basis for local management of reef areas and mainstream coral reef concerns into the local and national development management cycle it is vital that the importance, status and trends of coral reefs and the scope for intervention in Seychelles is effectively communicated to stakeholders and the general public alike.

Likewise, more detailed information needs to be readily available in an easily comprehensible, high-utility format to those who seek it.

Activity		Priority (1-3)	Time line	Agencies/Notes
5.1	Educate and engage the public on day-to-day actions they can undertake to reduce stress on coral and coral reefs.			
	5.1.1. Survey, and establish baseline for, status of public knowledge and current actions on coral reefs.	1	2021	MACCE/PECO
	5.1.2. Undertake stakeholder analysis to identify key reef users.	1	2021	MACCE/PECO
	5.1.3. Develop structured, targeted communication strategy with targets and OVIs.	1	end 2021	SAP SC, PECO, Stakeholders
	5.1.4. Survey status of public knowledge on coral reefs, assess effectiveness of and adaptively manage Communication Strategy.	1	2025	MACCE/PECO
5.2	Publicise social and economic values of coral and coral reef services provision (X-ref 3.3, 5.1).			
	5.2.1. Incorporate findings of Activity 3.3. into communication strategy	1	2024-25	SAP SC Stakeholders
5.3	Publicise status and trends of coral and coral reef health (X-ref 3.2).			MACCE/PECO, SAP SC.
	5.3.1. Publicise and disseminate a synthesis, in layman's terms, of the current knowledge on status and trends in Seychelles' coral reefs.	2	2022-25	MACCE/PECO, SAP SC, NGOs
	5.3.2. Incorporate scorecard system (and map) into communication strategy (X-ref 3.2, 5.3.1).	2	2024-25	

5.4	5.4.1. Raise awareness of SAP and measures being undertaken to promote reef conservation, sustainable use and resilience (X-ref WP 1-5).	2	2021 onwards	MACCE/PECO, SAP SC
	5.4.2. Incorporate into communication strategy.	1	end 2021	MACCE/PECO, SAP SC
	5.4.3. Update with mid-term review of SAP implementation.	3	2023	MACCE/PECO, SAP SC
5.5	Promote coral reefs in the school curriculum.			
	5.5.1. Review knowledge products and identify gaps.	1	2021	MoE, MACCE/ PECO, NGOs
	5.5.2. Update and add to knowledge products, as appropriate.	1	2022	MoE, MACCE/ PECO, NGOs
	5.5.3. Train educators in use of knowledge products.	2	2022	MoE, MACCE/ PECO, NGOs
	5.5.4. Effectively incorporate coral reefs into the school curriculum.	1	2023 onwards	MoE, MACCE/ PECO

Results		Indicators
5.1	5.1.1. Public baseline knowledge on coral reefs established.	Public knowledge assessment, analysis, recommendations in report.
	5.1.2. Key reef user groups identified and targeted in Communication Strategy.	Reef user assessment. Communication Strategy stakeholder analysis.
	5.1.3. Communication Strategy developed, tailored to local stakeholder and knowledge scenario and logically structured with clear targets, timelines and OVIs.	Communication Strategy Document and implementation reports.
5.2	Public made aware of coral reef economic value and importance.	Results of (5.1.4) survey of public knowledge. Number of civil society initiatives.

5.3	Reef status and trends publicised. Reef quality scored, mapped and publicly available/ disseminated.	Reports. Media spots. Website.
	5.3.1 & 5.3.2. Reef quality scored, mapped and publicly available/disseminated.	Score card system. Status of reef reports/website.
5.4	Public is aware of SAP, its work programmes and how it can be utilised it to galvanise and advance the conservation and sustainable use of coral reefs.	Communication Strategy Number of projects and project applications to donors from civil society.
5.5	5.5.1 – 4. School curriculum incorporates specific component on coral reefs.	School curriculum Improvement of knowledge on coral reefs in primary and secondary school leavers from 2023-2025. Number of coral reef educational materials and number of teachers trained in their use. .

Photo Credit | Christophe Mason-Parker

Status of Seychelles Coral Reefs

Status overview

Coral reefs in the Seychelles are under immense stress, with most of the shallow reef sites in the Inner granitic islands being composed principally of dead corals and a depauperate reef fish community. In 2020, average percentage cover on coral reefs in the inner islands was estimated to stand between 10 to 15%. Coral reefs in the outer islands are in healthier states with generally higher percentage of live coral cover and on average higher fish biomass than in the inner islands. However, there is high level of inter-island, site heterogeneity.

Socio-economic importance

Coral reefs and their associated mangrove and seagrass habitats are the most diverse and biologically important shallow marine ecosystems in the Seychelles. Out of the known marine species from the Seychelles (Bijoux et al 2003), it is well established that the majority are associated with coral reefs. Coral reefs are also important in fisheries through the provision of employment and an estimated 4,000 metric tons (SFA 2016a) of reef-associated fishes annually through the wild caught fishery, of which the bulk is used for local consumption while a small portion is exported.

A recent reconstruction of Seychelles' domestic catches within its exclusive economic zone from 1950 to 2017 suggests that the amount of reef-associated fishes that have been harvested is approximately 1.5 times larger than the baseline reported by the United Nations Food and Agriculture Organization (FAO) on behalf of Seychelles (Christ et al 2020). Catch estimates for the year 2017 puts total catch at around 11,000t (Christ et al 2020). Such level of domestic catch is supported by relatively recent fish consumption data which suggest that total catch might actually be around twice the official amount (Morel 2014), which does not as yet include catch made in the subsistence, sports and recreational reef fisheries. The Seychelles tourism industry is also highly dependent on coral reefs. Many visitors to the Seychelles participate in paid coral reef associated activities such as snorkelling, diving, yachting and glass-bottom boat excursions.

Coral reefs are also highly valuable for the formation of the white sandy beaches that remains some of the main attractions for tourists. They also have important coastal protection functions and play an important role in attenuating wave energy before they reach the shoreline. Coral reefs and the other habitats that they support are intricately linked with the Seychellois people and have high recreational, spiritual and cultural values. A 2004 study estimated the net present value of marine ecosystems of the

Seychelles to be worth US$ 1.5 billion (Cesar et al 2004). Whilst this is likely to be a gross under-estimation of the true value of marine ecosystems in Seychelles but serves to highlight the immense value that these ecosystems have.

Biogeography of Seychelles coral reefs

Fig. 1. Dendogram showing hard corals affinity and of ecoregions of the western Indian Ocean and Red Sea.

More than 300 species of hard corals (Order Scleractinia) from 66 genera have been predicted to occur in Seychelles waters (Veron 2000). However, the distribution of coral species is not uniform throughout the Seychelles archipelago as different species have different environmental requirements. Two different eco-regions are recognised in terms of the composition of hard coral biodiversity (Fig. 1).

The Northern Seychelles eco-region has lower species richness than the Southern Seychelles eco-region (Fig. 2). Hard coral communities in the Northern Seychelles eco-region are more similar to those found along the East Coast of Africa and the Mascarene Islands than to those found in the Southern Seychelles eco-region. In contrast, the coral communities of the Southern Seychelles eco-region tend to be more similar to communities found around the islands of the Comoros archipelago and the Madagascar micro-continent. The patterns of coral diversity in the Western Indian Ocean region is thought to be heavily structured by the South Equatorial Current which has created a centre of high biodiversity in the Northern part of the Mozambique Channel from which coral species are exported to other regions of the Western Indian Ocean by meso-scale eddies (Obura 2012).

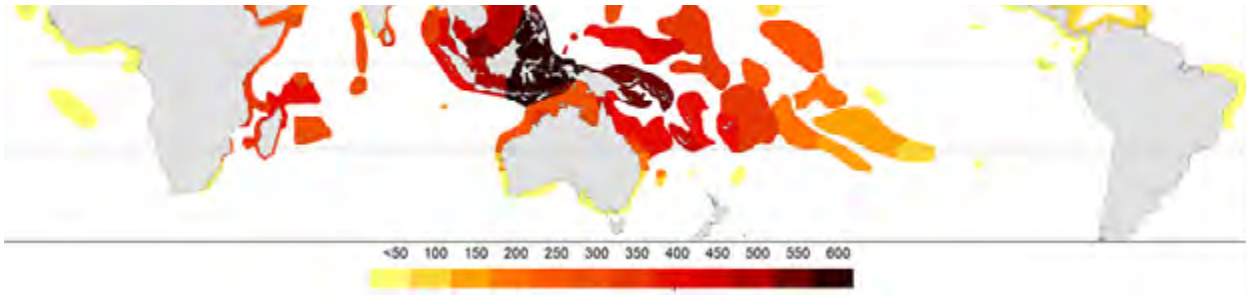


Fig. 2. Global distribution of hard coral species diversity. Source: Veron (2000).

Patterns of change

The current state of coral reefs is far from the colourful reefs patrolled by a high biomass of apex predators that Lazare Picault and his men would have observed when they first anchored around the Seychelles islands in 1742. From the early days of the discovery and settlement of the Seychelles islands, coral reefs were exploited and the reef communities started to change. Early on, the near-shore reefs were fished and salted fish featured prominently in the exports from the islands.

Corals from the reef flats were also mined to be used as bricks for construction and for the production of lime. Other threats that from early on shaped the patterns of change on the coral reefs around the larger inhabited granitic islands of the Seychelles include sedimentation caused by the erosion of soils from deforested hill slopes and overgrowth by algae fertilized by sewage runoff (Goreau 1998). It was not until the late 1960s and early 1970s that qualitative descriptions of coral reefs around the Seychelles started appearing in the scientific literature (Lewis & Taylor, 1966; Lewis 1968; 1969; Rosen 1971).

The early reports provided a mixed picture of the health of coral reefs in the Seychelles inner islands. The International Union for Conservation of Nature and Natural Resources (IUCN) undertook a mission to the Seychelles in 1978 to provide advice to the Government on conservation measures to support the long-term sustainability of the country's marine resources. The mission's report described the reefs of places like Baie Ternay and Anse Petit Cours as "beautiful" and having "rich and varied reef community" (Salm 1978). However, the report also noted that the "remarkable feature of reefs around the granite islands is the amount of dead coral". Already then, coral reefs in the Seychelles inner islands were undergoing degradation. Less than a decade before the publication of that report large areas of the reef flat on the East coast of Mahé Island had been reclaimed for the extension of Victoria and the construction of the international airport.

While there were qualitative descriptions of coral reefs of the Seychelles inner islands before the 1990s, the first quantitative estimates of live hard coral cover and fish diversity, biomass and abundance on the reefs around some of the granitic islands was published in 1995 (Jennings et al 1995). Patterns of change on the coral reefs of the Seychelles inner islands started to be monitored from that point onwards. Two years after this first baseline was established, an active outbreak of the corallivorous Crown of Thorns (COTS) starfish, Acanthaster planci, was reported on reefs in the northern parts of Mahé Island in late 1996. The outbreak caused widespread coral mortality at the sites where they were recorded. Such localised COTS outbreaks remained active until the middle of 1998 (Engelhardt 2000). These outbreaks are believed to be linked to nutrient enrichment of coastal waters, often through sewage runoff.

By then, in addition to the local stressors that were affecting patterns in coral reef communities, global changes brought about by increasing levels of atmospheric carbon dioxide and other greenhouse gases had also started to become apparent. The first observable manifestation of the global changes on the coral reefs of the Seychelles was in the form of the 1997/98 positive sea surface temperature anomaly (Spencer et al 2000; Wilkinson 1998).

In early 1998 calm weather, clear skies and high air temperature created the conditions which allowed water temperature in access of 33°C to develop not only in surface waters but also at depths down to some 20 metres (Engelhardt et al 2002). This warm water event resulted in the most severe coral bleaching event and death recorded in recent history, with the peak in bleaching-induced coral mortality occurring between February and May (Spencer et al 2000). Bleaching and subsequent death was not restricted to hard corals and were also recorded in other marine taxa such as alcyonaceans, non-scleractinian coelenterates (Stichodactyla and Heteractis) and bivalves (Tridacna spp.) throughout the Seychelles islands (Goreau 1998; Spencer et al 2000; Turner et al 2000). Before the 1998 mass coral bleaching event, average coral cover on the reefs in the Seychelles inner islands stood at around 42%. (Thérésine et al 2017).

Post bleaching surveys around the inner islands showed that the event had caused widespread coral mortality and average live coral cover had been reduced to less than 5% (Graham et al 2006; Turner et al 2000). However, the amount of coral mortality varied among sites (Engelhardt 2000; Turner et al 2000). After this event, live hard corals found on the reefs of the inner islands were mostly massive and sub-massive colonies of the coral genera Porites, Acanthastrea, Goniopora, Diploastrea and Physogyra, usually occurring towards the bottom of the reef slopes. The faster growing branching and tabular Acropora and branching Pocillopora that covered the greater proportion of pre-bleaching reefs were either dead standing or reduced to rubble at most sites, especially along the upper reef slopes (Turner et al 2000). Post-bleaching surveys likewise indicated that most species of corals have survived somewhere in the region, but that diversity at most sites was low. At that point it also became apparent that the reefs further away from the main islands of Mahé and Praslin had not faired any better (Turner et al 2000).

Extensive coral bleaching and death was also recorded in the Seychelles' outer islands during the peak of the bleaching event. In the outer islands, bleaching intensity varied among locations, between environments at the within-reef scale, and among coral growth forms with between 39% and 80% coral recorded being bleached or recently dead (Spencer et al 2000). At these southern islands, bleaching was not as extensive as in the inner islands and was generally worse in shallower waters (<10m). Mortality was particularly high in the branching corals Acropora, Pocillopora, Millepora (fire coral) and Heliopora (blue coral), with live Millepora being rare at all locations (Spencer et al 2000). Death in the massive corals such as Porites, Favia, Pavona, Platygyra, and Diploastrea was in most cases partial and spatially patchy at both the colony and reef scale. Contrary

to expectations, post-bleaching surveys in the lagoon at Alphonse Island found that coral mortality in the warmer lagoon was far lower than of coral colonies on the surrounding slopes, in deeper and cooler waters (Iluz et al 2008). These authors suggested that corals in the lagoon were protected from UV radiation by leachate stemming from seagrass leaves, which resulted in a strong attenuation of ultraviolet radiation which is not observed in clear waters.

It has also been suggested that corals in the lagoons were more tolerant to temperature fluctuations than corals in deeper water (Spencer et al 2000). In the southern islands, signs of decay within the reef architecture became apparent just after the mass bleaching event with the breakage of branching corals and high incidence of corals no longer in life form position (Teleki & Spencer 2000). Spaces between dead coral branches were observed to be filled in by algal turf and calcareous crusts or covered over by algae such as Lobophora. It could be anticipated from early on, that continued decay of the reef will impact the invertebrate and fish life as the post disturbance reef communities evolve.

The effect of coral reef degradation on associated reef biodiversity has not been extensively studied in the Seychelles apart from the effect on reef fishes. The impact of reef degradation on fish communities has been both lethal and sub-lethal (Graham et al 2006; Hempson et al 2018). Seven years after the 1998 mass coral bleaching event, fish communities on the reefs of the Seychelles inner islands were described as taxonomically depauperate. Surveys found that three main fish families had been heavily impacted through bleaching. They were the monacanthids, chaetodontids, and pomacentrids.

A few years after the event the possible local extinction of four fish species (Labrichthys unilineatus, Chaetodon lineolatus, Plectroglyphidodon johnstonianus, and Thalassoma hardwicke) and a reduction in abundance to critically low levels for six species (Oxymonacanthus longirostris, Chaetodon trifascialis, Chaetodon melannotus, Chaetodon meyeri, Plectroglyphidodon dickii, and Chromis ternatensis), all of which rely on live coral for key life processes, such as recruitment, shelter, or diet was noted (Graham et al 2006). For species that feed directly on corals, the obligate specialist feeders have tended to display the greatest declines after coral mortality with the obligate generalists also declining substantially, but facultative feeders show little change (Graham 2007). Early analysis of catch of commercial species did not indicate reduction in overall abundance of fish from the fishery (Grandcourt & Cesar 2003).

Recovery from the mass coral bleaching event was slow and there was a four year lag phase during which live hard coral cover fluctuated between 3 and 5% and showed almost no signs of increasing (Engelhardt et al 2002). By 2003, the reefs had started on a slow recovery trajectory, regaining about 2 percentage points of live coral cover each year (Payet et al 2005). This trajectory was maintained over the years despite multiple small mass bleaching events during this period. It became apparent, however, that not all reefs had the same level of resilience. At many locations, coral reefs had undergone

a widespread phase-shift from a coral dominated to a rubble and algal dominated state (Graham et al 2006; Ledlie et al 2007). Monitoring data shows that certain reef sites had embarked on a path to recovery to a coral dominated state whereas other sites had entered into a new stable state dominated by macro-algae (Graham et al 2015). At the sites that failed to regain their live coral cover, other studies suggested that there were certain demographic bottlenecks that were hindering the recovery by limiting the survival of coral recruits (Chong-Seng et al 2014) while good predictors of recovery potential such as habitat type, depth, grazers density and structural complexity also started to emerge (Graham et al 2015).

When regular reef monitoring started in 2000, carbonate and granitic reefs had approximately the same level of hard coral cover (Engelhardt 2000; Payet et al 2005; Thérésine et al 2017; Turner et al 2000). However, during the early stage of recovery, granitic reefs fared slightly better than carbonate reefs and recorded higher average coral cover in most years (Fig. 3). The higher rate of initial recovery on granitic reefs compared to carbonate reefs had in the past been attributed to a number of factors including: more suitable surface for recruitment, higher 3-dimensional complexity and ability to shed sediments, less competition by macro-algae as well as less abrasion resulting from mobile pieces of rubbles (Payet et al 2005). However, as time progressed, the differences in coral cover between granitic and carbonate reefs became less apparent.

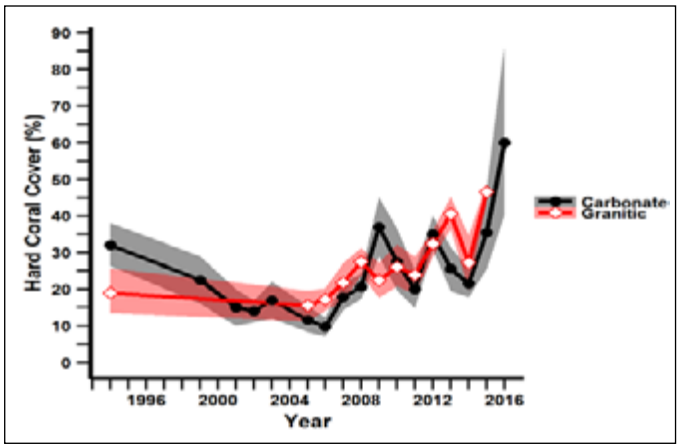


Fig. 3. Temporal rends in live hard coral cover between carbonate and granitic reefs in the Seychelles inner islands. Source: Thérésine et al (2017).

At the sites that recovered, recovery was primarily driven by faster-growing branching coral, particularly those from the family Acroporidae. However, at the initial phase, the coral community was dominated by coral genera other than Acropora, with very few Acropora colonies in the shallows having survived the bleaching event. In 2005, non-Acropora corals on average accounted for 12% of total reef cover compared to 1% for Acropora (Payet et al 2005). As time passed Acropora recovery accelerated, reaching 22% in 2015, when for the first time it surpassed mean non-Acropora coral cover (Thérésine et al 2017).

The level of site protection (Fig. 4) had been shown to be an important factor in the recovery of coral reefs by some studies (Thérésine et al 2017) but not by others (Graham et al 2015). Along the northwest coast of Mahé, it took a number of years after the impact for the effect of site protection to become noticeable. Historical data shows that between 2005 and 2012, sites located in protected areas had similar levels of live coral

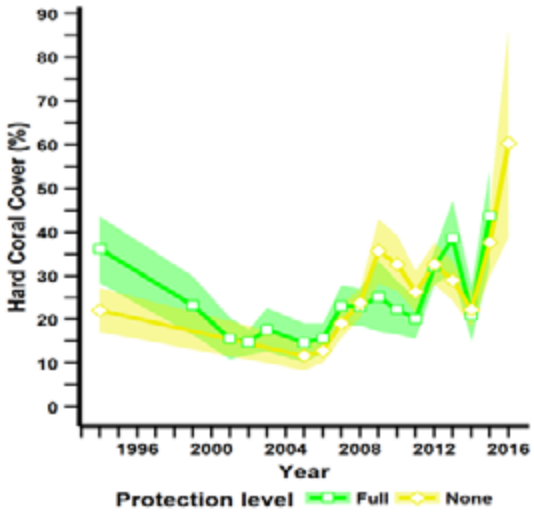


Fig. 4. Temporal rends in live hard coral cover between formally protected and unprotected reef sites in the Seychelles inner islands. Source: Thérésine et al (2017).

cover as those found at unprotected locations. However, by 2013 coral cover within protected areas exceeded that in unprotected areas by a margin of about 10%, showing the importance of formally protected sites in coral reef recovery (Thérésine et al 2017). This result is however contrasted by other studies that reported that whether reefs were inside no-take marine reserves had no bearing on ecosystem trajectory (Graham et al 2015).

It has been reported that irrespective of the reef type or whether a site is protected or not, there appear to be five major factors that correctly characterize post-bleaching reef trajectories. These factors include the density of juvenile corals, initial structural complexity of the reef, water depth, biomass of herbivorous fishes and nutrient conditions of the reef (Graham et al 2015). It has been documented in the inner islands that recovery was favoured when reefs were structurally complex and in deeper (> 6.6m) water, when density of juvenile corals and herbivorous fishes was relatively high and when nutrient loads were low (Graham et al 2015). This is supported by more recent analysis which shows that reefs with high juvenile coral densities and low nitrogen levels recovered the fastest, possibly due to the interplay between nutrient enrichment, algal proliferation, and coral recruitment (Robinson et al 2019a).

In the outer islands, coral reef monitoring has been done opportunistically and long terms trends in coral cover and recovery trajectories are not very clear for most sites. However, what was clearly noticeable was the large spatial variation in coral cover among the different islands.

The last status of coral reefs report highlighted that while coral reefs around islands like Etoile and African Banks were found to have mean live coral cover of around 10% or less, reefs around islands like Alphonse, Providence and St. Pierre had relatively high live coral cover. At Desroches some sites were reported to have live coral cover as high as 95% (Thérésine et al 2017). Monitoring at Aldabra revealed that mortality of coral at Aldabra following the bleaching event was approximately 66% at 10 m depth and 38% at 20 m depth (Stobart et al 2005). Around the Aldabra atoll, slow but gradual increase in hard coral cover has been observed since 1998 at shallow reef monitoring sites while deeper sites had remained fairly consistent (Thérésine et al 2017). Mean hard coral cover on the reefs of Aldabra in 2015 was around 30% on the shallow reefs and around 18% on the deeper reefs. Coral reefs of Aldabra had high level of spatial heterogeneity in coral

cover with coral cover at sites ranging between 2 and 80% (Chong-Seng 2015; Haupt et al 2015). At Farquhar, a 2014 survey described the coral cover and overall benthic community condition as poor and suggested that such conditions are likely to be due to a combination of limited habitat, localized upwelling, past coral bleaching, and cyclones (Friedlander et al 2014).

Long-term spatio-temporal data on coral reef fish abundance are rare. Where it existed, it has been difficult to reduce the data set down to metrics that can be directly compared among sites for a national level analysis. There are however a number of monitoring programmes which are collecting data to track patterns of change in coral reef associated fishes. One of the most notable programmes is the Global Vision International (GVI) / Seychelles National Parks Authority (SNPA) annual monitoring that has been covering 24 sites along the northwest coast of Mahé island since 2005. There is also a long-term programme focused on 21 sites around Mahé and Praslin initiated by Simon Jennings in 1994 and which has been continued by Nicholas Graham on a four to five-year timescale.

For the northwest coast of Mahé, post-bleaching reef-fish abundance data indicates that the density of fish on coral reefs remained relatively stable between 2005 and 2015 with mean relative abundance of 3,400 fish ha-1 (Thérésine et al 2017). The butterfly fish family (Chaetodontidae) was the only one to show clear long-term change with an increase in density of nearly five times (Fig. 5). This was correlated with an increase in live hard coral cover over the same period. Densities of the other families were found to have remained more or less constant.

Overall density of fish on carbonate and granitic reefs did not differ substantially but there was more variability on carbonate compared to granitic reefs. The data set recorded a long-term decrease in overall fish density on reefs within protected areas whereas reefs in unprotected areas appear to be showing signs of a slow but long-term increase in density. While this may be the case for the reefs along the northwest coast of Mahé, this trend is not supported by data from a wider geographical distribution within the inner islands, which indicates that whether reefs were inside no-take marine reserves had no bearing on ecosystem trajectory (Graham et al 2015). Indeed, long-term monitoring around the inner islands over a 17 years period indicates that functional diversity of associated reef fish communities shifted substantially following bleaching, returning towards pre-disturbance structure on recovering reefs, while becoming progressively altered on regime shifting reefs (Graham et al 2015) thereby indicating that the observed patterns of change in coral reef fish community is strongly linked with whether the reef benthos have regime shifted or not.

At Aldabra in the outer islands, surveys undertaken seven years after the mass bleaching event found no significant changes in total fish-species diversity, number of families represented by these species, or in the numbers of pomacentrid or chaetodontid species (Downing et al 2005), which is contrary to fish-diversity changes that have been observed on coral bleaching-impacted reefs elsewhere. Reef surveys at Farquhar

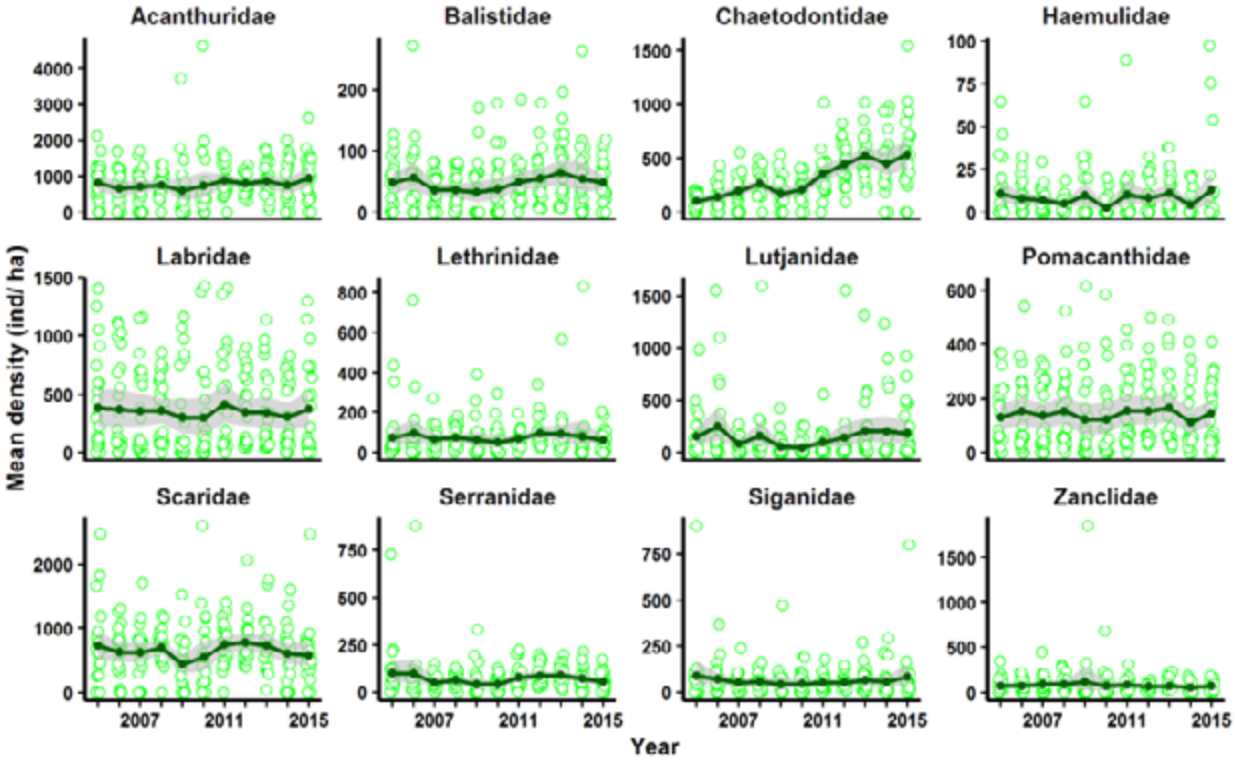


Fig. 5. Averages of fish abundance for 12 fish families on coral reefs in the Seychelles inner islands between 2005 and 2015. Source: Thérésine et al (2017).

described intact reef fish assemblages with very large biomass (3.2 t ha-1). The coral reef associated fish community at this atoll was described as being dominated by large groupers, snappers, and jacks with large (>1 m) potato cod (Epinephelus tukula) and marbled grouper (E. polyphekadion) being commonly observed at many locations, along with the IUCN Endangered-listed Napoleon wrasse (Cheilinus undulatus) and Vulnerable-listed bumphead parrotfish (Bolbometopon muricatum) (Friedlander et al 2014).

A second global mass coral bleaching event in 2010 did not have as marked an effect in Seychelles and coral reefs that had not shifted to macro-algae dominated states continued on the recovery trajectory. By 2015, average coral cover on the reefs of the Seychelles inner islands had returned to pre-1998 bleaching level (Thérésine et al 2017). It had taken 17 years for the reefs to reach this point while at other sites in the region recovery had been much faster (Ahamada et al 2004).

In 2016, the world succumbed to a third mass coral bleaching event and the Seychelles was impacted significantly. Sea-surface temperatures (SST) recorded by satellite from a fixed station in the Seychelles showed extreme thermal stress building up from December 2015 to May 2016 (Fig. 6). NOAA bleaching warning alert level 1 was reached early in January and intensified in late March. SST reached its highest value in April, well above the threshold for bleaching, and the bleaching alert level reached the maximum

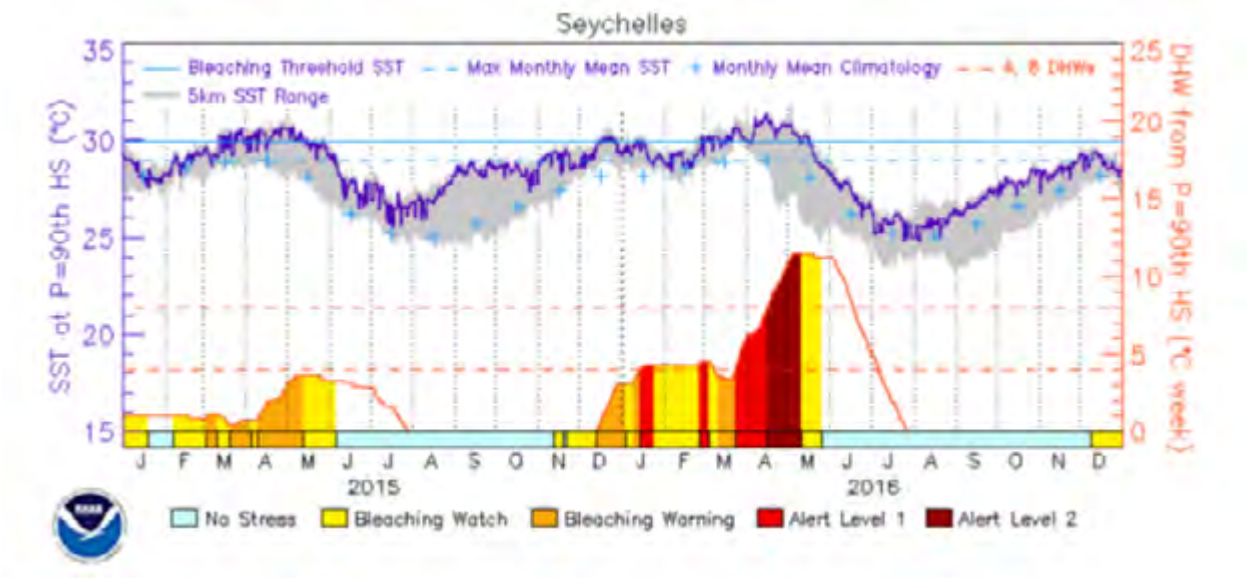


Fig. 6. National Oceanic and Atmospheric Administration (NOAA) Coral Reef Watch satellite bleaching products, showing the bleaching related conditions present at a remote monitoring station in Seychelles.

value of 2 at the beginning of April (Fig. 7). Thermal stress peaked at 12 Degree Heating Weeks [10] for three weeks in late April/early May (Gudka et al 2018).

The first signs of bleaching in 2016 were observed in the south of the archipelago at Aldabra in early January 2016, where 23 genera were found to be affected to different degrees. Full bleaching developed a few weeks later, peaking at 60-99% of all corals being affected (Chong-Seng 2016). Surveys during peak bleaching estimated mortality to be in the region of 14%, and only 13% of corals were recorded as healthy. Post-bleaching assessment recorded an overall drop of 50% in hard coral cover (Burt, A. pers. comm.)

From Aldabra, the event quickly made its way northwards. By the end of March, bleaching was observed around the island of Providence and St. Pierre, where it was reported to be mild with 20% of corals showing signs of stress (Thérésine et al 2017). By early April, bleaching was being reported from the island of Alphonse and Desroches in the Amirantes. The reef on the west side of Alphonse was found to be severely affected with 70-80% of the corals showing bleaching. Mortality was highest in the genera Acropora and Pocillopora. However, the eastern side of the same island was reported to be almost untouched with < 15% of hard corals showing signs of stress. At Desroches Island, temperature was found to steadily increase from around 28.5 to 30.4 °C from October 2015 to March 2016 (Bluemel 2016).

In the inner islands, the first observations of coral bleaching were made during mid-March with reports coming from multiple locations throughout the island group. On the

[10] Degree Heating Week (DHW) shows how much heat stress has accumulated in an area over the past 12 weeks (3 months) by adding up any temperature exceeding the bleaching threshold during that time period.

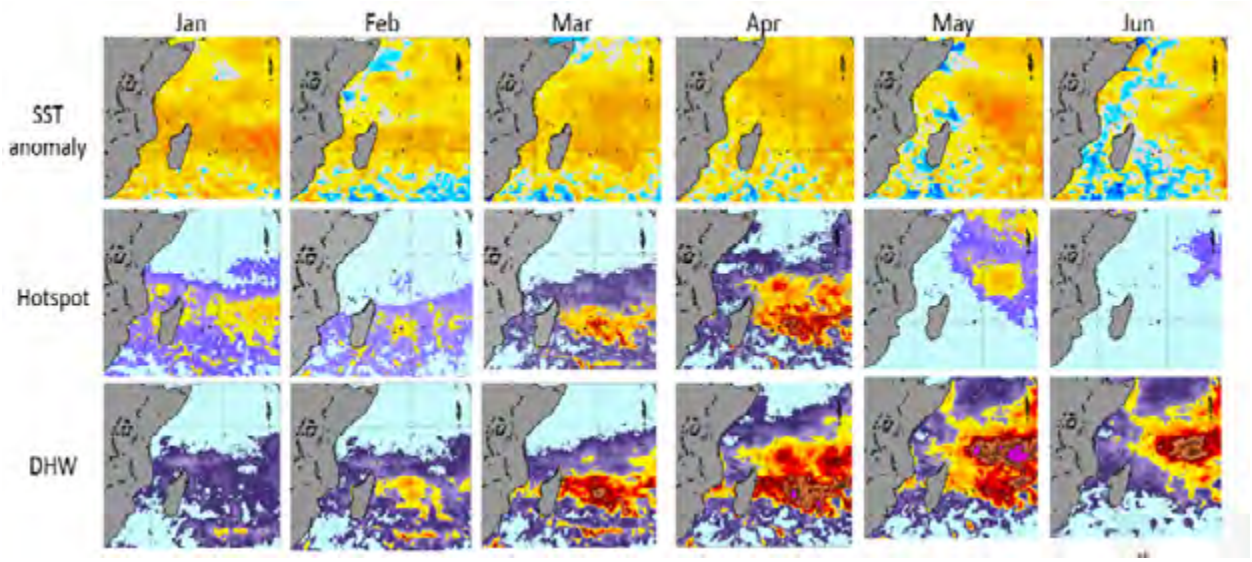


Fig. 7. NOAA Coral Reef Watch 5 km Satellite Coral Bleaching Heat Stress Monitoring in the WIO for the 15th of each month from January to June 2016. SST anomaly, hotspot and degree-heating weeks (DHW) are shown.

northeast coast of Mahé, the genera Pocillopora and Acropora were the first to show signs of bleaching at all depths. In subsequent weeks all hard coral genera, as well as other benthic organisms such as soft corals, corallimorphs and zooanthids were affected, across all sites visited. Areas with a high cover of branching, tabulate, digitate and sub-massive corals, such as on carbonate reefs, were affected more severely than sites with higher coverage of encrusting corals, typically granitic reefs.

Coral mortality was first observed in Pocillopora and in branching/tabulate Acropora colonies, estimated at 50% in some shallow areas of Baie Ternay, by the beginning of May. The worst affected genera were Acropora, Leptoseris, Pocillopora, Lobophyllia, Porites, Fungia, Diploastrea, Echinopora and Physogyra. Online reporting of coral bleaching on the CORDIO bleaching monitoring platform revealed that during the peak bleaching months (Jan-May) approximately 65% of sites (Fig. 8a) reported severe bleaching levels (greater than 50% of coral cover bleached), with just over 30% of sites reporting severe mortality from May onwards. The monthly progression of bleaching mirrored the increasing thermal stress (Fig. 8b).

Following the 2016 bleaching event coral cover on the reefs along the northwest coast of Mahe significantly decreased from an average of 42.1% mean coral cover in 2015 to 16.1% mean cover in 2017 and this was marked by a sharp decrease of Acropora corals and branching growth forms (Vessaz et al in prep.). However, the impacts of the 2016 bleaching event were less acute than the 1998 one, suggesting increased resilience and potential for the reefs to recover. Surveys of 18 reefs sites from different locations around the Seychelles inner islands found that one year after the bleaching event average coral cover had reduced from around 20% to 6%, similar to levels recorded in

2005, seven years after the 1998 bleaching (Wilson et al 2019). The decline in coral following the 2016 bleaching was linked to reduced abundance of fish <11 cm total length particularly corallivores, invertivores and mixed diet feeders. In the outer islands, at Aldabra seaward reefs were found to experience 51-62% reduction in hard coral cover after the 2016 event while lagoonal reefs suffered coral loss of about -34% of cover. By 2019, shallow reefs monitored at Aldabra had between 54% and 93% of pre-bleaching cover and full recovery was predicted to take at least five more years while deeper reef sites remained unchanged (Koester et al 2020). At D'Arros Island and St Joseph Atoll average live coral cover halved after the 2016 event. Despite the reduction in coral cover the percentage of macro-algae remained low and stable (Gadoutsis et al 2019). Similar

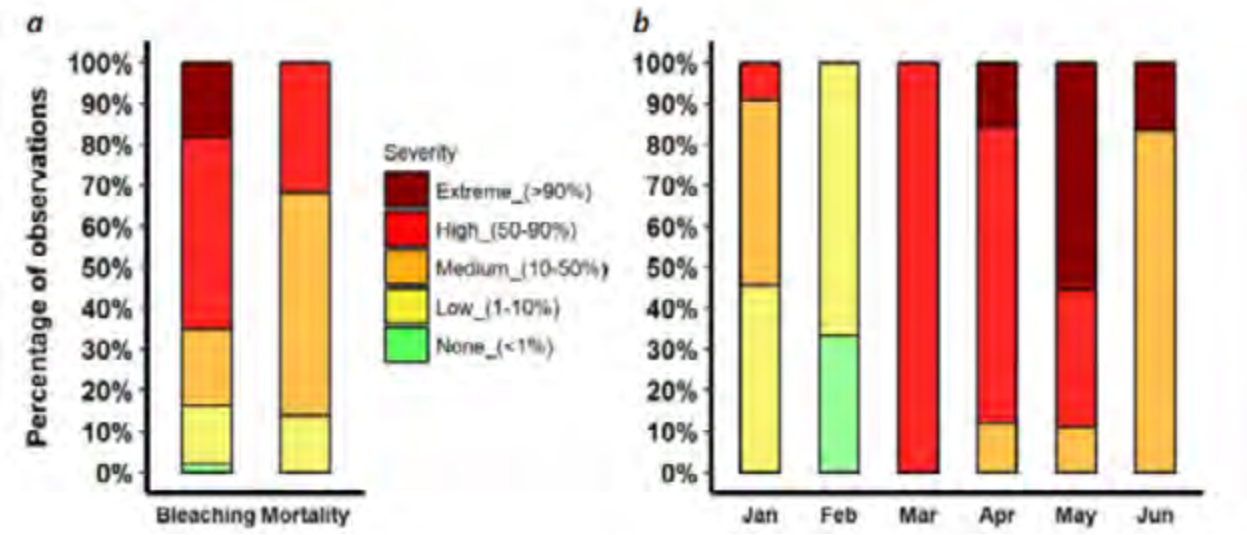


Fig. 8. Breakdown of observations in the Seychelles in 2016 of a) coral bleaching from January-May (n=49) and mortality from May-September (n=22); b) bleaching each month (Jan; n=11, Feb; n=3, Mar; n=1, Apr; n=25, May, n=9, Jun; n=6). Categories represent the severity of bleaching/mortality reported as percentage of coral cover bleached/dead at a site. Source: Gudka et al (2018).

observations were made after the 1998 bleaching event at Aldabra and it has been suggested that the lack of additional anthropogenic pressures at these remote locations may make the reefs more resilient to bleaching-related population changes (Downing et al 2005).

Patterns of change on Seychelles' coral reefs in the past two decades have been driven mostly by global stressors which continue to be exacerbated by local stressors acting at much smaller scales. In the next section we briefy explore some of the drivers of change.

Drivers of change

A number of stressors acting on the local and global scales are responsible for the observed changes in coral reef health in the Seychelles. These drivers are outlined below.

Ocean warming: Extended periods of elevated sea surface temperature have been linked to mass coral bleaching events and widespread death of corals and degradation of coral reef structure (Engelhardt 2000; Graham et al 2006; Spencer et al 2000; Turner et al 2000). Periods of elevated sea surface temperature in Seychelles were recorded in 1998 and 2016. Live coral cover on the reefs of the inner islands were reported to have decreased from an average of 42% to less than 5% after the 1998 coral bleaching event. Not all reef sites were able to recover after the event as some had shifted to rubble and macro-algae dominated states. For those that were able to recover, it took 17 years for them to regain their pre-1998 live coral cover. The 2016 mass coral bleaching event reversed nearly all of this gain when it reduced coral cover to around 10% (Thérésine et al 2017; Wilson et al 2019a). Coral reefs in the outer islands have also been severely affected with recovery there appearing to be highly variable (e.g. Koester et al 2020).

Over-fishing: Many reef-associated fishes in the Seychelles are believed to be being over-fished. Recent analysis of long-term catch data from the whaler and schooner hand line fishery have shown important signs of decreasing catch per unit effort for most of the fish groups that are monitored (Robinson et al 2020). Concerns of overfishing of certain coral reef associated species have been raised for some time now (Grandcourt et al 2008; Gutierrez 2011; 2015) Over-fishing has been known to trigger system-wide trophic cascades which have the potential to drive regime shifts in aquatic systems and establish less productive and biodiversity poor habitats. Such regime shifts in the Seychelles have previously been attributed to ocean warming (Robinson et al 2019b). Over-fishing is known to be a contributor to this regime shift but has yet to be quantified.

Physical alterations and destruction: Local destruction of coral reefs has occurred through dredging and reclamation for the creation of land for development. The reef flats along the East coast of Mahé have been the most affected. Part of the reefs have been dredged to obtain the calcareous materials used to create new land on other parts of the reef flats. The last major land reclamation project was completed in 2008 and it is estimated that around 250 ha of reefs have been reclaimed. In 2019, the Cabinet of Ministers approved the Phase IV of East Coast reclamation which will include the extension of Ile Aurore, Ile Hodoul and the reclamation of the Victoria yacht basin, Queenie Bay and Zone 20. Ad-hoc reclamation of the reef flats continues on a small scale. Opening and maintenance of reef channels for navigation, incidences of vessel grounding and anchor damage also continue to damage coral reef ecosystems.

Pollution: This includes sedimentation from poor land management practices, eutrophication resulting from the discharge of high level of nutrients into the coastal environment, oil and chemical discharge from landfills, workshops and factories, as well as marine debris of local and foreign origins. Pollution changes the chemical balance in coastal waters and affects the development of corals and other reef associated fauna. Input of nutrients also favours the growth of macro-algae which compete for space with corals and can contribute to phase shifts to algal dominated reefs. An important source of nutrient input to the reef environment in the Seychelles is through sewage linked to the household use of septic tanks.

Plague species: The most noticeable plague species with repercussions for coral reefs in the Seychelles to date are the Crown of Thorns (COTS) starfish (A. planci) (Engelhardt 2000) and black-spine sea urchins (Thérésine et al., 2017). While these species are native to the Seychelles, trophic cascades and nutrient enrichment have resulted in conditions, at certain sites or during certain times, which enable their population to explode. In 1997/1998 and 2014/2015 population explosions of COTS were reported along the North West and West coast of Mahé island which resulted in excessive predation of corals. Plague density of black spine sea urchins has also been linked to suppression of reef recovery through excessive grazing on coral recruits (Hung Dang et al 2020).

Coral diseases: Several coral diseases have been reported from the Seychelles. At certain locations, incidences are widespread and are now reported to be affecting a greater diversity of coral species. The diseases are responsible for the gradual decay of coral colonies and have been known to be spread from one coral colony to another by grazing fishes (Nicolet et al 2018; Shore & Caldwell 2019). The prevalence of coral disease has also been linked with sewage, tourism activities and water temperature anomalies (Harvell et al 2007; Lamb et al 2014; Ruiz-Moreno et al 2012).

Harmful algal blooms: Events of harmful algal bloom seem to be becoming more frequent in the inner islands. The last major event in 2015 was extensive and could be observed several tens of kilometres away from the main islands. Occurrence of algal blooms often results in fish kill of reef associated species and has contributed to localised coral bleaching events.

Implications for management

The continued degradation of Seychelles' coral reefs has important implications for management. Though ocean warming remains the principal driver of degradation, there is little that the Seychelles can do on its own to directly address the underlying cause of climate change which is linked to increase in atmospheric carbon dioxide. What Seychelles can do is to manage its reefs in a way that builds resilience to ocean warming. The indicators of reef resilience are well known and include: strong recruitment, broad community size and age range, high biodiversity, low human impacts, healthy population of herbivores, low incidences of coral disease and a history of surviving stresses. Resilience of Seychelles coral reefs can be improved by reducing the intensity of the direct anthropogenic stressors. Strategies for consideration include:

- Raise awareness in the local communities on the importance of balancing conservation efforts and the sustainable use of coral reef ecosystem.

- Adopt conservation and fisheries strategies that lead to the reconstruction of keystone fish populations for reef ecosystems. These includes trophic groups such as herbivores
  which help in controlling macro-algae density on reefs and species like triggerfish and the Giant triton conch (Charonia tritonis), which feed on COTS and black spine sea urchins.

- Put in place appropriate infrastructure to improve the treatment of sewage and decrease the input of nutrients, chemicals and solid waste into coastal waters.

- Develop, implement and enforce legislations to ensure that threats to coral reef ecosystems are systematically addressed, particularly those linked to fisheries, tourism and coastal development.

- Implement and enforce legislations that will reduce impacts of international trade in coral/coral reef resources.

- Prevent, prepare for and respond to oil and chemical spills to reduce impacts on coral reefs.

- Promote the rehabilitation of degraded coral reefs and associated habitats and the testing of new methods and techniques aimed at improving recovery of degraded coral reefs.

The effectiveness of these strategies should be supported by institutional structures and complementary actions that:

- Organise, encourage and facilitate monitoring of coral reefs and preparation of coral reef status reports to evaluate the performance of management measures in place and to promote adaptive coral reef management.

- Promote pragmatic home-grown research and international research collaboration that seeks to improve our understanding of the functioning of the coral reef ecosystem and its associated habitats to enable science-based decision making and improved management.

- Facilitate adoption of new knowledge and best practice generated and employed in other countries, states and territories with coral reefs.

These management measures have budgetary implications. It is therefore necessary that the Seychelles Government and the stakeholder community is able to identify the appropriate mechanisms to leverage new and additional funds to strengthen the management of coral reefs.

Photo Credit | SIF

Recommendations for Coral Reefs Restoration

Coral reef restoration projects are being undertaken by a number of different organisations in the Seychelles. Projects have varied in scale from a few to 1000s of square meters (e.g. Maya et al 2016) and in objective from restoration of ecological services to basic public education and awareness. Thus far, the organisations involved have developed and tested their own techniques. Generally, the "coral gardening" approach has been used in which coral fragments harvested from the wild have been allowed to grow in nurseries before being transferred onto the restoration sites. At the global level, several guidelines and manuals on coral reef restoration have been produced (e.g. Precht 2006; Edwards 2010; Johnson et al 2011). Regionally, potentially complementary guidelines have been prepared for the restoration of mangrove and seagrass ecosystems.

When planning a coral reef restoration project it is important to take a number of factors into consideration. One of the most important, is the restoration method or methods that will be used. Different methods and techniques are currently being used in different parts of the world. A systematic review of current methods, successes, failures and future directions in coral restoration has recently been undertaken by Boström-Einarsson et al (2020), which recognised eight main coral restoration methods with some variants. These include:

- **Direct transplantation:** This is the earliest and most common method of coral restoration. It involves the direct transplantation of coral fragments, from a donor to a recipient reef.

- **Coral gardening:** This method involves the rearing of coral recruits or small fragments in intermediate nurseries, prior to planting on restoration sites. In this method coral can be raised in either field-based (in situ), or land-based (ex situ) nurseries, depending on local conditions.

- **Micro-fragmentation:** This technique has been used mostly with massive and encrusting coral life-forms. The technique makes use of a diamond blade saw to cut small fragments
(1 cm2) of massive/encrusting corals, which are then mounted on tiles. After about 12 months the tiles are secured to reef substrates or dead coral skeletons in arrays that will readily fuse together to form larger colonies.

- **Improving genetic diversity in asexual propagation:** This technique makes use of assisted fertilisation and the creation of nursery stocks from the larvae of brooding corals. The technique is used to improve genetic diversity in coral reef restoration, which is not catered for in asexual propagation methods.

- **Larval enhancement:** There are two main variations of this method. One variation makes use of harvested gametes with embryos reared ex-situ. Subsequent settlement is onto a range of artificial structures developed to improve post-settlement survival rates. In the other variation, coral gametes are collected during spawning and the embryos and larvae are subsequently reared in holding tanks or on the reef. Larvae are then released directly onto the reef in enclosures that retain them over the target substrate during the settlement period.

- **Artificial reefs:** This technique involves the creation or addition of substratum for coral settlement and growth. The structures are deliberately placed on the seabed for colonisation by coral larvae.

- **Substrate stabilisation:** This technique involves stabilisation of rubble in an area that has been affected by physical impacts. The most common method is to install mesh, netting or concrete over the rubble to prevent further movement. The stabilised surface can be left for natural settlement by coral larvae or they are used as a precursor to the transplantation of corals onto the damaged area and/or additional deployment of artificial structures.

- **Substratum enhancement with electricity:** This technique mimics the chemical and physical properties of reef limestone, by encouraging the precipitation of calcium and magnesium on artificial substrata. Electrodes and electrical current are used to precipitate calcium carbonate. The purpose of this method is to potentially increase the calcification of coral polyps, thereby boosting colony growth and resilience to stressors. However, results have been mixed, which prohibits clear conclusions about the mineral accretion method.

In the Coral Reef Restoration Toolkit: A Field-Oriented Guide developed in the Seychelles Islands that was produced by Nature Seychelles as part of their Reef Rescuers Project (Frias-Torres et al 2019), the coral gardening method is promoted. This is indeed the technique which is being used by the majority of organisations involved in coral reef restoration in the Seychelles to date. The method has been tested and found to work well in the Seychelles context. As such, the toolkit is a useful resource for any organisation planning to undertake coral reef restoration using the coral gardening technique as it provides detailed step by step instructions.

Depending on the local situation, certain methods may need to be combined to enhance the overall effectiveness of the project. Ideally, an implementer would utilise a method that provides the highest return per unit of investment but those techniques requiring high level of skills or complex equipment may not be suited to the local scenario. Since coral reef restoration science is still in its infancy, the Seychelles should not to confine itself to a single technique. Before any coral reef restoration project is undertaken it is recommended that a clear plan of implementation is produced. The plan of implementation should provide an outline of the restoration objectives, the stakeholders' involvement process, restoration site(s), nursery site(s), techniques that will be used, candidate species, nursery design, maintenance requirements, field protocols, monitoring techniques and procedures for project management and evaluation. It should be noted that coral gardening is considered as a licensable aquaculture activity and falls under the auspices of the Fisheries (Aquaculture) Regulations (2020).

Recommendations for Coral Reef Monitoring and Research

Coral reef monitoring is an important tool for assessing the condition, long-term trends and the effectiveness of management actions on coral reefs. Assessing and monitoring coral reef conditions is important to understanding and reducing many threats to these ecosystems. In the Seychelles' inner islands, coral reef monitoring is being undertaken on at least 50 sites at various frequencies ranging from annual to once every 4 years (Thérésine et al 2017). In the outer islands, some baselines of benthic and fish community structure have been established at many sites but only a few of them (e.g. Aldabra, D'Arros Island and St Joseph atoll, Desroches) have regular long-term monitoring in place. The lack of coral reef monitoring in the outer islands has mostly been due to logistical constraints.

Most data is being collected by the private sector, foundations, NGOs and universities. From time to time the ministry responsible for the environment collates key indicators of trends to prepare state of coral reefs reports. Most of the quantitative benthic monitoring data which is collected in the Seychelles is done using the Global Coral Reef Monitoring (GCRMN) recommended line intercept transect (LIT) method (English et al 1997). This method of benthic monitoring makes it possible to summarise benthos data to a few highly informative matrices such as percentage coral cover, percentage macro-algal cover, percentage Acropora coral, percentage non-Acropora corals, rubble, bare substrate, etc. This is very useful for combining data from various monitoring programmes. This is not as straight forward for reef fish monitoring data as often only part of the fish community is monitored and species, groups or families are chosen based

on specific survey objectives requiring different levels of accuracy (e.g. family abundance, species abundance, total species length, length according to pre-determined ranges, etc). Not all monitoring programs include the monitoring of coral recruits and densities of reef macro-invertebrates. The following recommendations are thus made to strengthen coral reef monitoring in the Seychelles.

- Strengthen the national inter-organisation structure for coordinating and undertaking coral reef monitoring.

- Develop a nationally coordinated coral reef inventory that adopts widely used methods for reef monitoring and make use of the Coral Reef Monitoring Manual South-West Indian Ocean islands (Obura 2014) for regular monitoring and the Coral Reef Bleaching Monitoring Guide Western Indian Ocean (Obura 2016) for bleaching monitoring.

- Develop a long-term, holistic program of ecological studies of coral reefs to improve our understanding of the underlying processes that supports healthy coral reefs in Seychelles.

- Track and assess changes in coral reef communities in response to environmental stressors or specific human activities/uses.

- Create accurate baselines for long-term monitoring of catastrophic damage from natural/anthropogenic events.

- Support strategic research focused on the determinants of coral reef health and recovery, including, bleaching and diseases.

- Support and implement strategic research aimed at assessing the status of deeper coral reefs, banks and sea bed.

- Conduct focused socio-economic studies on high risk anthropogenic threats to coral reef habitats in order to resolve important user conflicts.

- Whenever possible, include monitoring of fish community, coral recruitment and macro-invertebrates in the monitoring programme.

- Put a system in place to facilitate the submission of data on key matrices from coral reef monitoring to the ministry responsible for environment.

- The responsible agency should prepare a national status of coral reefs report at least once every two years, and ensure that it is widely distributed and reaches the highest level of government.

- A system should be put in place to share metadata on coral reefs in the Seychelles to facilitate information sharing and foster inter-agency accountability, collaboration and coordination.

Strategies to Promote Sustainable Fisheries on Coral Reefs.

The following strategies are recommended to protect coral reef ecosystems from the harmful effects of overfishing:

- Identify, monitor and protect critically important coral reef fisheries habitats and spawning populations.

- Set-up fisheries independent monitoring programmes to monitor the status of fisheries resources in coral reefs ecosystems.

- Strengthen existing fisheries catch monitoring to better document catch landed and effort in different types of coral reef fisheries and spatially link catch to fishing locations.

- Expand existing fisheries catch and effort surveys to include the sports, recreational and subsistence fisheries.

- Introduce legally binding measures to prevent exploitation of fish spawning aggregations.

- Improve fisheries compliance through education and awareness, improved surveillance and enforcement of regulations.

- Increase involvement of resource users and local communities in fisheries management initiatives.

- Strengthen the management of existing Marine Protected Areas, operationalise and prepare regulations for newly designated marine protected areas and sustainable use areas under active management to attain their stated fisheries objectives.

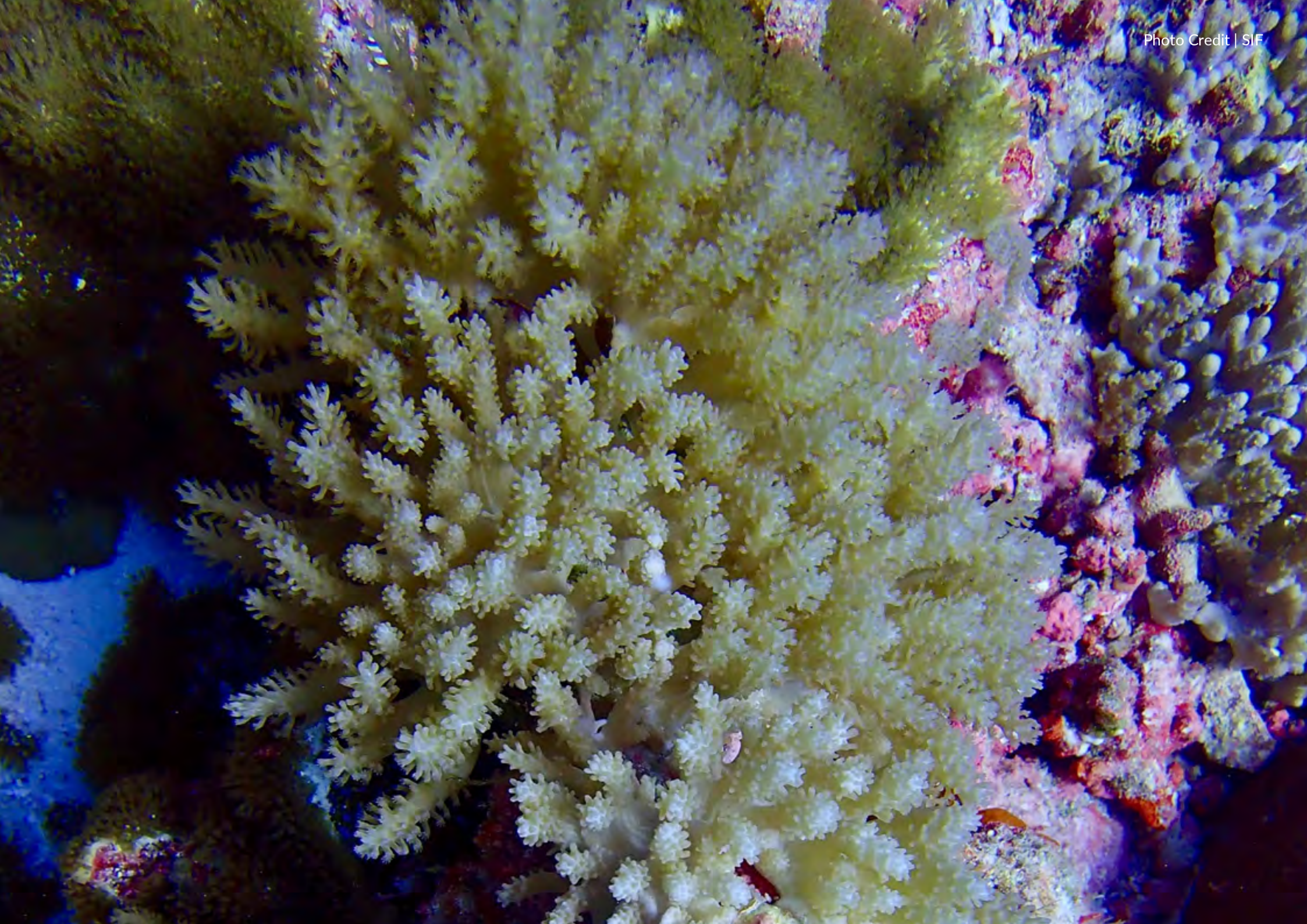


Photo Credit | SIF

Coral Reef Governance in Seychelles – a situation analysis

The Seychelles has a complex and nuanced marine governance structure. This reflects progressive and ad-hoc development on a sectoral basis, through time, with perhaps insufficient consideration given to harmonising legislation and initiatives respectively across portfolios. This elaboration is ongoing with the recent promulgation of the 2016 Environment Protection Act (GoS 2016) , and its extended powers in the marine domain, the current draft revision of the Fisheries Act (a recent iteration of which proposed sweeping new powers) the Town and Country Planning Act (Physical Planning Bill) and the National Parks and Nature Conservancy Act (NPNCA) (Nature Reserves and Conservancy Bill)(GoS 2020); as well as the development of the proposed Seychelles Oceans Authority, its associated legislation (the SOA establishment Bill – GoS 2020a) and where it will fall ultimately in the governance structure.

The current situation is therefore dynamic and the resulting structure 18 to 24 months from now remains unclear and thus poses problems for reviewing marine governance in Seychelles for the purposes of the development of the coral reef strategy and action plan.

The current broader marine governance structure is set out in Figure 9 overleaf. This figure does not include reference to the proposed Seychelles Ocean Authority (SOA), its related legislation (the SOA establishment Bill) or the portfolio under which it will ultimately fall, beyond reference to the Marine Spatial Plan (MSP) Initiative currently residing under the ambit of the Ministry of Agriculture, Climate Change and Environment (MACCE).

The portfolio is split across several sectors the threads only coming together at the level of the Cabinet of Ministers. With specific reference to coral and coral reefs however, the core portfolios are the Ministry of Agriculture, Climate Change and Environment (MACCE), the Ministry of Fisheries (MoF) and the Ministry of Lands and Housing (MLH). MACCE's purview is realised through its legislation (National Parks and Nature Conservancy Act and Environment Protection Act). MoF's mandate is derived from the Fisheries Act and realised primarily through the Seychelles Fisheries Authority (SFA). MLH's powers are derived from the Town and Country Planning Act and realised primarily through the Act's mandated Planning Authority.

It is surprising therefore to find that, despite overlapping portfolios, an abundance of legislation and the key socioeconomic importance of coral reefs to Seychelles, that there is, to date, no legislation that regulates coral and coral reefs in a generic sense. Only in protected areas under the NPNCA are there specific regulations protecting coral. At the time of writing this document, the Government of Seychelles (GoS) is in the process of

preparing legislation (Trade of Wild Fauna and Flora Bill) to meet its obligations under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and this should therefore cover the trade of CITES Appendix listed species of coral.

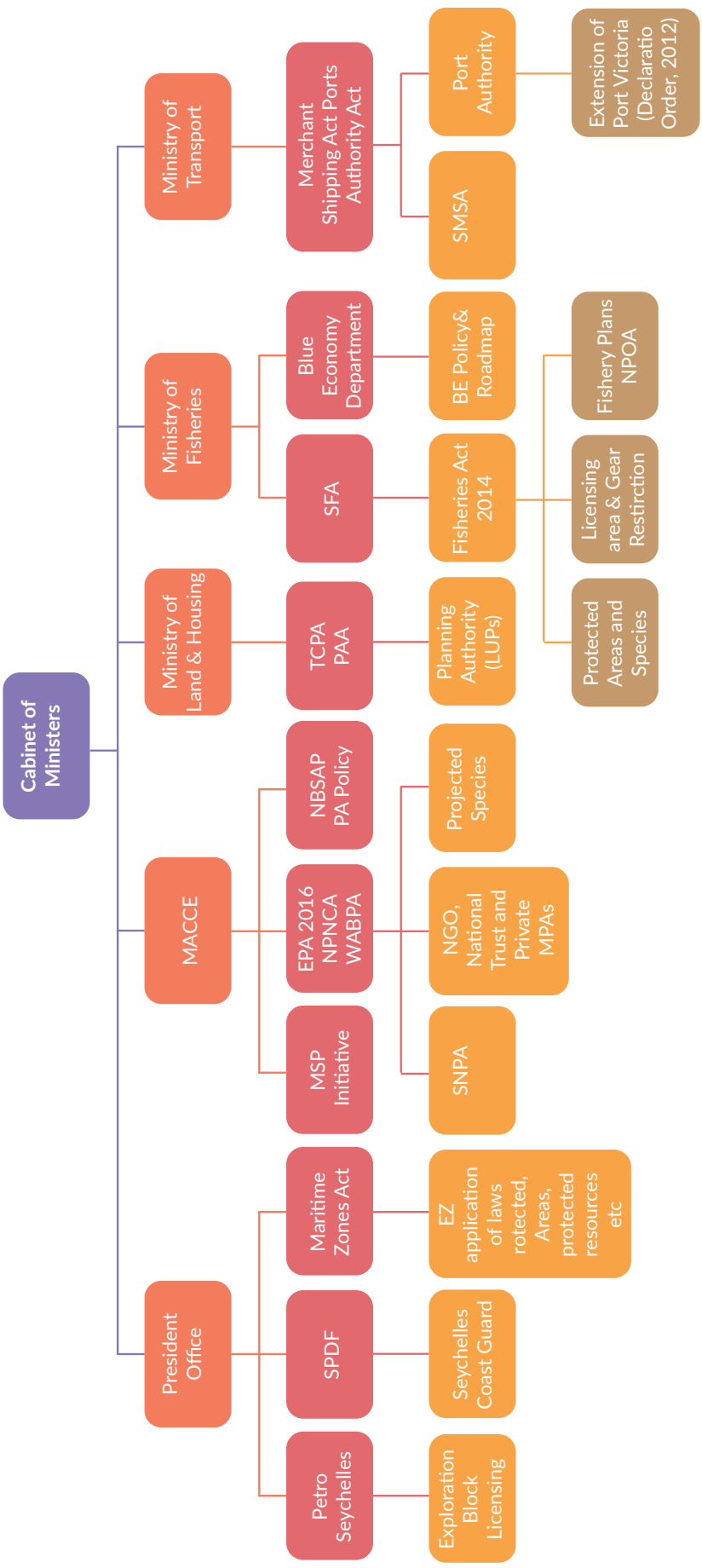


Figure 9. Seychelles Marine Governance Structure

Legislative Framework

National Parks and Nature Conservancy Act (GoS 1969)

The Aride Island and Cousin Island Special Reserve regulations state it is an offence for any person who:

"removes, or wilfully disturbs any humus, soil, sand, mud, gravel, rock, **coral or reef debris**, for any purpose whatsoever from or in any part of the Reserve,"

Aldabra Special Reserve regulations has very similar text to the same effect.

Ste Anne, Curieuse and Ile Cocos marine national park regulations also offer protection to coral within their boundaries, though to lesser and varying extents, with a common minimum that anchor damage to coral is an offence.

The NPNCA does provide enabling clauses for the general protection of coral, however. "Wild life" is defined as: "all animals whether on land or in the sea, plants together with the biotopes necessary for their survival **and coral**"; and under Section 16 the Minister is empowered to make regulations generally for carrying out the objects and provisions of this Act inter alia to "provide for the protection of wildlife". This power has not been utilised to date however except within the regulations of protected areas as noted above.

The latest (March 2020) draft of the Nature Reserves and Conservancy Bill provides under section 26. (1) Offences, part (c) that:

A person who *"destroys, removes, causes to be destroyed or causes to be removed, or attempts to destroy or to remove would, trees, forests,* **corals**, *mangroves, seagrass and associated species or other habitats found in, produced on or stemming from a protected area"* commits an offence.

This only appears to apply however to coral that lies within a designated protected area and as such represents a significant contraction of powers from the current NPNCA [11]. A single reference under Part XI Miscellaneous Section 32 (2) c which in full context reads as follows:

"32.(1) The Minister may make regulations generally for carrying out the provisions of this Act.

(2) Without prejudice to the generality of subsection (1), regulations may inter alia provide for —

(c) the conservation of biological diversity, including but not limited to the conservation of habitats and wildlife outside a protected area;"

Section 2 of the Act defines "biological diversity" as *"the variability among living organisms from all sources including, inter alia terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part and includes diversity within species, between species and of ecosystem;"*

This single reference without context established elsewhere in the Bill is much weaker than the extensive explicit powers and context provided in the NPNCA. It is also notable that clause does not refer to the "sustainable use" of biological diversity which further limits its scope and utility.

It is pertinent to note here that the Protected Areas Act (GoS 1967) primarily intended to cover areas of national security has also been utilised for the designation of protected areas for environmental purposes. Namely the 1987 designation of African Banks and Ile Coco protected areas. The African Banks protected area designation is particularly pertinent because its full title reads Protected Areas (African Banks and surrounding Reefs) Order, 1987. (SI 41 of 1987). This legislation makes it forbidden for unauthorised persons to enter the designated area and clearly includes the coral reefs and banks in the vicinity. The responsibility for African Banks lies with MLH and there is no enforcement. The Ile Coco protected area designation under this legislation was superseded by its subsequent designation as a marine park under the NPNCA in 1997.

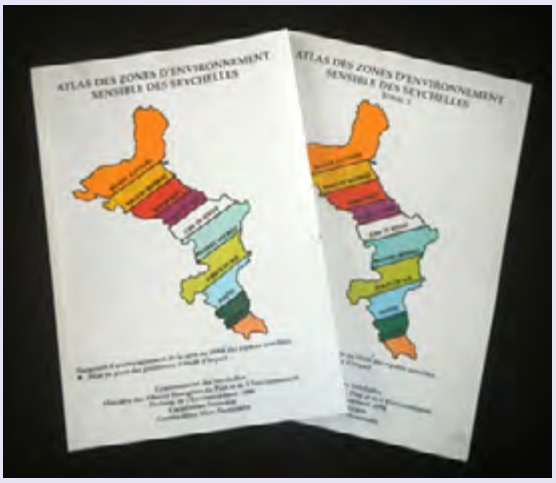
Environment Protection Act (2016). (GoS 2016)

The Environmental Protection Act (EPA) 2016 repealed and replaced its predecessor the EPA 1994 (GoS 1994). The EPA is the primary piece of legislation for the mainstreaming of environmental and biodiversity concerns into the national development cycle. Its function is intended to be complementary to the TCPA which applies its own criteria for safety and building standards. The planning and environmental assessments undertaken by the respective technical agencies are considered together under the auspices of the Planning Authority. The EPA and its EIA regulations **(GoS 1996)** set out criteria for the provision of environmental authorisation for development proposals including, where appropriate, the need for category I or II EIAs depending on the scale and nature of the proposed development and its location relative to important environmental (physical or biological) areas/features. To enable this the EIA regulations identify some 22 categories of Sensitive Area inter alia the littoral sea floor, coastal zone and beaches. It is very interesting to note that coral reefs are not explicitly cited as a distinct sensitive area in the Sensitive Areas Atlas (Duncombe 1996a, 1996b) but rather fall under the generic heading of "fonds marin du littoral" (See Info Box 1).

[11] It is possible that this redefining of powers takes into account the expansions of power the environment portfolio under the Environment Protection Act 2016

Info Box 1: The Sensitive Area Atlas and Coral Reefs (and associated shallow marine ecosystems).

The Sensitive Areas Atlas (SAA) (Duncombe 1996a & 1996b) was developed to provide a basis for the scoping and undertaking of Environmental Impact Assessments (EIAs). It is an excellent document in particular considering the means and scope for access to information in Seychelles at that time. The SAA identified 22 categories of sensitive area and mapped them throughout the central Seychelles. Sensitive area categories range from coastal zone, through various sites of biodiversity value, catchment areas to areas of natural or industrial risk. Interestingly, despite their particular biodiversity and socioeconomic importance there is not a sensitive area classification specific to coral reefs. Rather coral is grouped with other benthic habitats (inter alia sandy zones, sea grass beds, mangroves etc...) under a generic heading of "fonds marin du littoral" or nearshore sea floor.



The SAA does however propose the development of detailed map of the coastal coral reefs and thereby the identification of sensitive areas that require protection. The mapping process was undertaken in 1997 but was immediately followed by the severe bleaching event of 1998 which was deemed to nullify the merits of the map. Management focus at that time then shifted in principle to the protection of coral refugia. As a consequence the intended designation of coral sites was never undertaken and can be considered a contributory factor to the relative lack of protection coastal reefs have received subsequently. These measures if implemented however would only have protected the nearshore reefs and likely would not have had any impact upon the latter phases of Reclamation undertaken due to their perceived national priority and also due to the fact that the Reclamation Act makes no provisions for coral reefs. Coral reefs throughout the plateau, outside of the very small protected areas, would have remained without specific protection.

The new EPA, however, imbues considerable additional new powers to the Ministry responsible for Environment in the marine domain, the sea floor and with regard to the conservation of coral and coral reefs in the Seychelles. In particular the EPA defines the term wetland as follows:

"an area of mangrove, marsh, swamp or water, which are permanent or temporary [sic] submerged (with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction) under fresh, brackish or salt water that is static or flowing including areas of marine water in which at low tide, where [sic] the depth does not exceed six metres, and includes riparian and coastal zones adjacent to the wetlands, and island [sic] or bodies of marine water lying within the wetlands, which have a depth of not more than six metres at low tide."

Shortcomings in drafting aside, this provides for an exceedingly broad definition of wetlands, and a significant expansion of the definition in the 1994 EPA:

"wetland" includes all freshwater and tidal areas that are or may be submerged or periodically submerged under fresh or salt water, including all bodies or areas commonly referred to as marshes, swamps, beaches and flats."

The new definition means that wetlands to be considered as sensitive areas, will include extensive areas of coral reef throughout the Mahé Plateau and the southern banks.

The EPA 2016 imbues the Minister for Environment with broad ranging powers pertinent to shallow marine environments including coral reefs (see **Table 1**, specific pertinent provisions are highlighted by **bold text**) including: standards and safeguards for water quality, regulations for the protection of water including fishing and recreational areas, the declaration and regulation/protection as appropriate of the coastal zone but none more so than the definition of development for which the EPA can be applied, and thus Environmental Authorisation required. The definition is comprehensive with the extensive list of criteria concluded with the "catch all" provision of:

"(x) any use of land, sea or building as determined by the Minister."

Table 1. Provisions of the 2016 EPA pertinent to Coral Reefs and Associated Shallow Marine Ecosystems	
Section	**Text**
14	**Standards and Safeguards** The Minister may prescribe standards and safeguards for: a) quality of air, water or soil for various areas and purposes; b) effluent limitations for existing and new point sources; g) pesticide and other residues in the environment.
15	**Regulations for Protection of Water** The Minister may by regulations provide for: a) the preservation of fishing areas, drinking water sources and reservoirs, recreational and other areas where water may need special protection; and b) carrying out works which appear to be necessary to prevent, control or abate water pollution from natural causes, abandoned works, developments, projects or activities not excluding measures to remedy and restore integrity of the affected area.
16	**Classification, Reclassification of Water** 1) The Minister may classify all waters in Seychelles based on their best usage. 2) The Minister shall, in making classification under subsection (1) have regard to section 5, and take into consideration the following factors: a) the existing quality of the body of water at the time of classification; b) the size, depth, surface area covered, volume, direction and rate of flow, gradient of stream of the body of water; and c) the most beneficial use and value for public water supplies, propagation of fish, recreational purposes, agricultural, industrial and other legitimate uses. 3) Where the public interest so requires, the Minister may re-classify a body of water based on intended beneficial use and take such steps as may be necessary to upgrade the quality of such water.
17	**Deterioration of Water Quality and Upgrade** Where the quality of water has deteriorated to such a degree that its state adversely affects its best usage, the Minister may, in co-ordination with other public bodies associated with water quality management, take measures as deemed necessary to upgrade the quality of such water to meet the prescribed water quality standards.
28	**Declaration of Coastal Zone[12] and its Protection** 1) The Minister may, by notice published in the gazette declare one or more Coastal Zones with subsidiary zones therein to cater for: a) sensitive zones of high cultural, recreational and aesthetic value; b) no development and climate based zones; **c) zones dedicated to the preservation and rehabilitation/conservation of coastal biodiversity;** d) zones as reclaimed naturally or artificially.

[12] The term Coastal Zone is not defined in "Section 2 Interpretation" giving considerable leeway to the discretion of the Minister.

Section	Text
29	**Survey of Coastal Zones and Preparation of Integrated Coastal Zone Management Plan** 1). The Ministry may make or cause to be made a survey of the Coastal Zones and may prepare or cause to be prepared an integrated Coastal Zone management plan based on the report of the survey. 2). The report of a survey made under subsection (1) shall include: a) an inventory of all structures, roads and excavations, harbours, outfalls, dumping sites and other works located in the Coastal Zone; **b) an inventory of the state of the coral reefs, mangroves and marshes found within the Coastal Zone;** c) an inventory of all commercially exploitable mineral deposits, both proven and suspected, located within the Coastal Zone; d) an inventory of all areas within the Coastal zone of scenic value or of value for recreation purposes. **e) an inventory of all estuarine or wetland areas within the Coastal Zone with an indication of their significance as fisheries or wildlife habitat;** **f) an inventory of all areas within the Coastal Zone of special value for research regarding coastal phenomena, including fisheries and sea erosion, littoral movements and related subjects;** **g) an estimate of the quantities of sand, coral, sea shells and other substances being removed from the Coastal Zone;** h) an estimate of the impact of erosion on the Coastal Zone; i) an estimate of the extent, nature, causes and sources of coastal pollution and degradation; j) an inventory of all users and uses of the coastal zone paying particular attention to the interactions/mixed uses of resources by stakeholders. **k) any other relevant data or information that may be deemed necessary.** 3). The Ministry shall as circumstances require: a) review the Integrated Coastal Zone Management Plan prepared under subsection (1); b) take necessary measures to restore, rehabilitate or protect all or part of the coastal zone as recommended by the survey prepared under subsection (1).
30	**Regulations of Activities in Coastal Zone** **1) The Minister may make regulations to ensure that activities in the Coastal Zone are conducted so as not to cause damage to the environment and to provide for such measures as are necessary to prevent, reduce and control pollution in the Coastal Zone.** 2) Notwithstanding the generality of subsection (1), regulations under that subsection may provide for: a) the control and prevention of pollution of the marine environment from land-based sources, including rivers, estuaries, pipelines and outfall structures; b) such other matters relating to the preservation and conservation of the Coastal Zone.
31	**Regulations for Exploration and Exploitation** 1) The Minister may make regulations to govern the environmental performance of petroleum and mineral exploration and exploitation activities within the territorial waters and, or the Exclusive Economic Zone of Seychelles, which shall include: a) requirements for preparation of Environmental Impact Assessments; b) applicable discharge quality standards and atmospheric emission standards;

	c) environmental management planning requirements; d) contingency plans for releases of oil and other polluting substances; e) management measures for use and handling of polluting or hazardous substances; **f) requirements relating to conservation of biodiversity.**
43	**Definition of Development** 1) In this Act, "development" b) Includes: (x) any use of land, sea or building as determined by the Minister.
44	**Environmental Authorisation** 1) A person shall, before carrying out: a) a development as provided for under this Act; b) a prescribed project or activity; or c) a project or activity in a protected or ecologically sensitive area as may be prescribed under this Act or any written law, obtain an environmental authorisation from the Ministry.

The Fisheries Act (2014) (GoS 2014)

The Fisheries Act (2014) describes itself as an:

"An act to provide for efficient and effective management and sustainable development of fisheries in accordance with international norms, standards and best practice and an ecosystem approach to fisheries."

In Section 3. Interpretation, it crucially defines "fish" as follows:

*"any aquatic plant or animal with the exception of birds, and includes any fish, crustacean, mollusc, **coral**, echinoderm, holothurian, or aquatic reptile or aquatic mammal and its shell, eggs and any other naturally occurring products stop."*

This therefore means all subsequent powers under the Act that can be applied to any fish or fishery[13] can be applied to coral and hence coral reefs. This enables full protective and management measures to be applied to coral and coral reefs should the Minister and/or Seychelles Fisheries Authority, as appropriate, so choose.

The objects of the Seychelles Fisheries Authority under this Act (Section 4), the provisions for a fishery management plan (Section 5) and management measures (Section 6) are reproduced in **Table 2**, with pertinent aspects highlighted by bold text.

[13] "fishery": (a) means one or more stocks of fish, vessels and gears used to capture fish and which can be integrated as a unit for the purpose of conservation, management and development of fishery; and (b) includes the activities leading to, resulting in, and resulting from the harvesting of fish through the capture of wild fish or the raising of fish through aquaculture;

It is appropriate to note here however that the current demersal fishery plan does not include specific measures to protect coral and indeed despite repeated reference to an Ecosystem Approach to Fisheries actually contains no substantive measures tailored to that context. Neither has the Act been used to date explicitly to protect coral or coral reefs.

The Act does however carry over regulations from its preceding legislation (Fisheries Act 1986) which serve to protect coral and coral reef habitats most notably those that prohibit demersal trawling and the use or possession of poisons and explosives for use in fishing:

Fisheries Act (1986)

"Part III Enforcement

Offences 24.(7) Any person who uses any poisonous or explosive substance to kill, stun or disable fish in order to render them more easily caught shall be guilty of an offence and liable on conviction to a fine of R 100,000. (Consolidated to 30 June 2012)"

"Subsidiary Legislation

> Fisheries Regulations. Part IV –Fisheries Management
> 14. No person shall use any demersal trawl net for fishing in Seychelles waters."

Fisheries Act (2014)

"Part VII - Miscellaneous

Repeal 78. The Fisheries Act, 1986

Savings and transitional provisions 79. (1)

All regulations made, directions issued and notification issued under the repealed Act shall continue in effect, in so far as they are not inconsistent with this Act, until they are repealed or amended under this Act."

Table 2. Pertinent Sections of the Fisheries Act, 2014 (Act 20 of 2014) 17th October, 2014.	
Section	**Text**
4	**Objects of the Authority under this Act.** The objects of the authority under this act shall be to provide for the effective management and sustainable development of fisheries in accordance with: a) internationally recognised norms, standards and best practice including the United Nations Convention on the Law of the Sea (1982) and the code of conduct for responsible fisheries, 1995 of the Food and Agriculture Organisation, Indian Ocean Tuna Commission conservation and management measures; and b) an ecosystem approach to fisheries which ensures that the development and management of fisheries addresses the multiple needs and desires of the society without jeopardising the options for future generations to benefit from the full range of goods and services provided by marine ecosystems.
5	**Plan for management of the Fishery** 1) the authority shall prepare and keep under review the plans for management of the fishery. 2) a plan for management of a fishery may set out: a) the current state of the fishery; b) the biological, ecological and socio-economic objectives for the fishery; **c) the management strategy for the fishery including biological, ecological and socio-economic indicators and reference points;** d) the management measures by which the objectives and strategy are to be attained, including harvest control rules; e) the amount of fish or fishing effort to be allocated, if the measures include quota systems, between individuals or fishing fleets; **f) measures to mitigate ecosystem impacts in accordance with the best practice for adoption of an ecosystem approach to fisheries, including by catch and habitat damage;** g) the licensing measures to be applied; h) the role of stakeholders in decision-making relating to the management plan; and i) performance criteria against which, and timeframes within which, the measures taken under the plan of management may be assessed.
6	**Management measures** 1) The Minister may make regulations prescribing measures for the proper management of the fishery. 2i) without prejudice to the generality of subsection (1), regulations may provide for: a) closed seasons; b) closed areas or waters; **c) species of fish to be regulated;** **d) specifications of authorised gear;** e) size or other characteristics of fish; **f) prohibited fishing method and gear;**

6	g) limitation of catch effort by restricting entry or by determining a total allowable catch or total allowable effort including the establishment of any quota system allocating catch or effort; h) fishing capacity controls; and **i) by catch, discards and habitats to be avoided.** 2ii) Any regulations made under this section prescribing management measures may regulate the following- **a) taking, possessing, purchasing, selling, importing or exporting of any gear or fish; or** b) engaging in fishing or fishing related activities in the closed areas or waters or possessing or using a vessel, aquaculture equipment, fish aggregating device or anything else in the closed areas or waters.

The Town and Country Planning Act (1972) (GoS 1972)

The TCPA establishes the Planning Authority which reviews planning applications and accepts with or without conditions or rejects them. There is an appeal process. The Act also sets out the required basic standards for structures in terms of their design, location, proximity to environmental features such as water courses, quality of material used and safety requirements etc…

The TCPA has a very wide mandate as imbued by its own definitions.

As per Part IV Control of Development of Land, sections 7 (1) & (2):

7 (1) Subject to the provisions of this section and to the following provisions of this Act, permission shall be required under this part for any development of land that is carried out after the appointed day and any person who carries out any such development without permission under this Act, or without complying with any condition imposed by the Minister or Planning Authority in granting any such permission shall be guilty of an offence and liable on conviction to the penalties prescribed in section 15.

(2) In this Act, except where the context otherwise requires, the expression "development" means the carrying out of building, engineering, mining or other operations in, on, over or under any land…

Crucially land is defined in Section 2 as follows:

"land" includes land covered with water, the sea-bed and buildings and other things attached to land, and in relation to the acquisition of land under Part VI includes any interest in or over land;

In other words the TCPA can technically require that its approval be sought for any activity, not just physical development, at land or sea within the territory of Seychelles[14], and when in joint application with the Maritime Zones Act (see below) throughout the Seychelles EEZ.

Furthermore in terms of development decision-making and approval, Section 10 of the Act actually places all power ultimately in the hands of the Minister responsible for the land use portfolio and in a manner the Act suggests is beyond legal reproach:

10 (1) The Minister may give directions to the planning authority requiring that any application made to the authority for permission to develop land, or all such applications of any class specified in the directions, be referred to him instead of being dealt with by the planning authority, and any such application shall be so referred accordingly.

(2) Where an application for permission to develop land is referred to the Minister under this section, the provisions of subsections (1) and (2) of section 9[15] shall apply, subject to any necessary modifications, in relation to the determination of the application by the Minister as they apply in relation to the determination of such an application by the planning authority.

(3) Before exercising any of the powers conferred by this section the Minister may, if he considers it expedient so to do, appoint one or more persons to inquire into and make recommendations on such matters as he may specify. Such person or persons shall keep or cause to be kept a record of any evidence taken and shall report their findings and make recommendations, to the Minister. The Minister shall consider the record, if any, the report and the recommendations, but he shall not be bound to follow such recommendations.

(4) The decision of the Minister on any application referred under this section shall be final and shall not be questioned in any court.

Application of the above definitions and provisions means that the Ministry in question can claim legal authority over all marine planning and development activities including any on, above or below the sea floor. Thus the Act empowers the Ministry such that it could promulgate regulations to protect coral and coral reefs either directly or by prohibiting activities that may impact them. Likewise, the Minister in his/her individual capacity[16] , by applying Clause 10, can also exercise such powers.

Another important piece of legislation in the context of coral and coral reefs is the Maritime Zones Act. This legislation falls under the President's Office and provides the legal basis for Seychelles' exertion of its rights over its Exclusive Economic Zone

[14] A list of maintenance operations and agriculture or forestry activities that do not involve building operations are excluded from this definition.
[15] Subsections (1) and (2) of section 9 set out the powers of the Planning Authority.
[16] The latest draft of the Physical Planning Bill as seen by the consultants, proposes to significantly reduce the powers of the minister in this regard, allowing such powers only in the case of national interest and emergency. These terms have yet to be adequately defined however.

- the sea bed and the natural resources found therein and in the water column- and the Continental Shelf. This legislation is therefore central to Seychelles designation of Protected Areas and the conservation and sustainable use of biodiversity beyond the limits of its territorial sea and archipelagic waters, as defined in the United Nations Convention on the Law of the Sea, 1982 (UNCLOS). Thus for example the protected areas designated under the Marine Spatial Plan using the NPNCA that fall outside of territorial/archipelagic waters will ultimately also require promulgation by order of the President under Section 30 of the Maritime Zones Act.

The Maritime Zones Act (Act 2 of 1999, with effect from 1st July 2000). (GoS 1999)

The powers under this Act are detailed and expansive, those elements of particular pertinence to coral and coral reefs are listed in **Table 3** with key elements in **bold typeface.**

Table 3. Pertinent Sections of the Maritime Zones Act (Act 2 of 1999)

Section	Text
10	Subject to this Act, Seychelles has, and has always had, in relation to the exclusive economic zone —
	a) sovereign rights for the purpose of the exploration, exploitation, **conservation and management of the natural resources, whether living or non-living, of the seabed** of the zone and the subsoil of and superjacent waters to the seabed as well as for producing energy from tides, winds and currents; e) exclusive jurisdiction to regulate, authorise and control marine scientific research; f) **jurisdiction to preserve and protect the marine environment** and to prevent and control marine pollution.
12.(1)	Subject to this Act, Seychelles has, and has always had, on or over the continental shelf
	(a) exclusive sovereign rights for the purpose of the exploration and exploitation of natural resources;
12.(2)	In subsection (1) (a), **"natural resources" means** mineral and other non-living resources of the seabed and subsoil **together with living organisms belonging to the sedentary species being organisms which, at the harvestable stage, either are immobile on or under the seabed** or are unable to move except in constant physical contact with the seabed or subsoil.
25.(1)	Subject to this Act, a person shall not within the exclusive economic zone or on the continental shelf —
	(a) explore or exploit any resources of the exclusive economic zone or the continental shelf; (b) carry out any search or excavation; (c) conduct any research;

	(d) drill on or construct, maintain or operate any artificial island, offshore-terminal, installation or other structure or device; or (e) carry out any economic activity, except under or in accordance with an agreement with Seychelles under this Act or another written law.
30.(1)	The President may, by Order published in the Gazette, extend, with such exceptions and modifications as may be specified in the Order, the application of any written law to the exclusive economic zone or the continental shelf or any part thereof, and an enactment so extended shall have effect in relation to the exclusive economic zone or the continental shelf as the case may be.
30.(2)	An Order made under subsection (1) shall be consistent with the international obligations of Seychelles.
33.(1)	The President may make such regulations as the President considers necessary for carrying out the purposes of this Act and without prejudice to the foregoing, the President may make regulations for all or any of the following matters — a) the regulation of the conduct of any person in the archipelagic waters or territorial sea, in the exclusive economic zone or on the continental shelf; b) regulating, In relation to the exclusive economic zone — i) the exploration for, and exploitation, conservation and management of, natural resources (other than sedentary species) whether living or non-living, of the sea bed, sub-soil and superjacent waters; ii) other activities for the economic exploitation of the exclusive economic zone; iii) the protection and preservation of the marine environment and the prevention and control of marine pollution; iv) the construction, operation and use of artificial islands, installations and structures; and v) the authorisation and control of marine scientific research; c) regulating, in relation to the continental shelf — i) the exploration for, and exploitation and management of, natural resources; ii) the preservation of the marine environment and the prevention and control of marine pollution; iii) the construction, operation and use of artificial islands, installations and structures; and iv) the authorisation and control of marine scientific research;

The **Land Reclamation Act (GoS 1961)** was also covered as part of this review, but it makes no explicit reference to coral or coral reefs rather couching issues in terms of adverse impacts on the rights of adjacent land owners, the general public and impact upon the (above water) aesthetics of the coastline.

Strategic and Policy Framework

Legislation sets the parameters of what powers the authorities may develop or bring to bear, regulations can define the scope of what is technically and legal and illegal. Strategic national approaches (national and sectoral policies, strategies and action plans) however define the framework within which agencies operate day to day and into the medium-term future; and how legislation is to be (pragmatically) applied. The initial scoping process for this review identified 16 national strategic and/or policy documents for review in the context of coral and coral reefs in Seychelles. Of these 12 were found to be of peripheral relevance and they are summarised in **Table 7**. The documents of direct relevance are discussed below.

Seychelles National Biodiversity Strategy and Action Plan, 2015-2020 (NBSAP) (GoS 2014a)

The NBSAP is Seychelles' primary strategic biodiversity document. It is designed as the country's plan to meet its commitments under the Convention on Biological Diversity (CBD). This document is the country's second NBSAP and was one of the first globally to be aligned with the Aichi Biodiversity Targets i.e. the strategic framework and targets of the CBD.

The NBSAP summarises status and trends of Coral reefs and associated shallow marine ecosystems (see **Tables 4 & 5**) below and discusses trends 1998-2014 in live coral cover.

Table 4. Description and Status of Marine and Coastal Biodiversity

Main Habitats	Typical/Key Species	Status
Coral Reef (Incl: reef ridge, slope, patch reefs etc)	Fauna: Scaridae (23 species of Parrotfish: e.g. Bolbometopon muricatum, Chlorurus sordidus, Hipposcarus harid, Leptoscarus vaigiensis, Scarus ghobban), Serranidae (Groupers: e.g. Cephalopholis sonnerati, Epinephelus chlorostigma, E. fuscoguttatus, E. polyphekadion, Plectropomus laevis), Lutjanidae (e.g. Lutjanus sebae, L. gibbus, L. sanguineus) Amphiprion fuscocaudatus (endemic), Octopus, lobster spp, Eretmochelys imbricata, more than 400 coral species. Numerous mollusc spp (including Cypraea helvola, C. histro etc...). Diverse elasmobranch populations including: Carcharhinus amblyrhynchos, C. melanopterus, Triaenodon obesus, Himantura uarnak etc...	Severely degraded by 1998 bleaching event (90% loss of live coral cover on Mahe plateau and 50% on outer banks). Important habitat for diverse and abundant biodiversity and specific biodiversity assemblages. Important tourism resource and source of recreation to local population.

Table 5. Trends in Marine and Coastal Biodiversity		
Habitat	**Trend**	**Notes**
Sea Grass	?	↘: Evidence of localised decline in inshore grass beds around main populated islands due to factors such as reclamation, dredging, siltation and pollution. ? : Insufficient data on large offshore sea grass beds to provide baseline – though removal of/dramatic reduction in key grazer species (e.g. Chelonia mydas) suggest likelihood of destabilisation.
Reef Flat	↓	↘: Extensive land reclamation on the main granitic islands. ↘: Excessive disturbance, utilisation and increasing pollution.
Coral Reef	↓	↘: Ongoing loss of rugosity and phase shift following 1998 bleaching event. ↘: Recurrent bleaching events 2002, 2003, 2010 inhibiting recovery. ↘: Anthropomorphic stresses on reef systems include widespread overfishing and sedimentation and physical damage near main populated islands. ↘: Reclamation.

The NBSAP lists an initial 31 projects and provides for a mechanism to develop and include more. On review of the initial 31 projects, 11 were found to have pertinence to the Coral SAP, 3 of which were considered to have strong relevance.

The NBSAP identifies and summarises the Key Threats to Biodiversity in Marine Ecosystems (see **Table 6**) over-fishing constitutes the primary and most immediate threat and in particular with regard to demersal stocks where there is strong and clear evidence of decline in many species and collapse of some populations, particularly of megafauna. Climate change is again a cross-cutting and complicating factor. In Seychelles the prolonged raised sea temperatures in 1998 caused severe and extensive coral bleaching and death resulting in some 90% and 50% loss of live coral cover in the central archipelago and outer islands respectively.

Recovery from this bleaching has been patchy and hindered by subsequent bleaching episodes. Issues of changing currents and shifts in seasonal weather patterns may impact the occurrence and distribution of migratory and pelagic species with ramifications for conservation and sustainable use. The rising level of atmospheric carbon dioxide is also driving acidification of the marine environment which is a longer term threat to marine biodiversity. Finally the ongoing exploration for oil and its potential future exploitation pose significant risks for biodiversity on the Mahé plateau and beyond.

Table 6: Threats to Biodiversity			
Ecosystem type	**Threats**	**Direct and Indirect Drivers of Threats**	**Implications**
Marine and Coastal Biodiversity	Over Exploitation	Economics Lack of management capacity, inappropriate incentives.	Unsustainable exploitation of resources, extensive future income loss and impact upon livelihoods, cost of living etc... Potential phase shift in some habitats.
	Pollution	Economic development Oil exploration and extraction. Lack of management capacity	Impact upon localised coastal habitats and production (broader threat of oil shipping and exploration).
	Coral Bleaching	Climate Change, Sedimentation, pollution, over exploitation etc...	Economic loss in artisanal fisheries and tourism industry, rise in cost of living, potential for ecosystem phase shift and ↑ coastal erosion.
	Sea Temperature change	Climate Change	Change in occurrence and distribution of pelagic resources, change in weather patterns, increased frequency of coral bleaching events etc...
	Sea Level Change	Climate Change	Loss of biodiversity, coastal erosion, potentially disastrous socioeconomic impact as economic activity and habitation focused on coastal plains.

Analysis of the NBSAP Objectives (equivalent to the Aichi Biodiversity targets) in relation to the Coral SAP provides a good basis for discussion to develop the Action Plan with stakeholders.

National Marine Spatial Planning Policy and Action Plan (GoS/TNC 2017)

The stated Goal of the Seychelles Marine Spatial Planning Initiative is to:

Develop and implement an integrated marine plan to optimise the sustainable use and effective management of the Seychelles marine environment while ensuring and improving the social, cultural and economic wellbeing of its people

The MSP Initiative was further structured with 3 primary objectives - that by 2020 the MSP will:

- Designate new marine protected areas that are 30% of Seychelles' Exclusive Economic Zone and Territorial Sea.
- Align and integrate with the Blue Economy and other national initiatives in Seychelles,
- Address climate change in coastal and offshore habitats.

Central to the initiative was that the 30% areas chosen constituted viable and representative habitats and ecosystems – and hence of course incorporated coral reefs into those planning criteria. This provides a key foundation for any subsequent approach to sustainable coral reef management.

The policy made various statements of intent and principle salient amongst which for the Coral SAP were:

"Noting the fundamental importance of science to develop, guide and adaptively manage Seychelles marine spatial plan and the need to promote scientific capacity and research in Seychelles, inter alia in ecology, economics and social science, to address the shortfall in key information on the marine environment and its optimal management;"

"Commits through the development, implementation and periodic review of the Marine Spatial Plan to the conservation and sustainable use of the marine environment, the mitigation of climate change and the promotion of the Blue Economy and to cooperate internationally as appropriate to further those ends."

Seychelles Fisheries Sector Policy and Strategy 2019 (GoS 2019)

This document provides a clear, sound platform for fishery development in line with best current practice and hence a good basis from which to develop the Coral SAP. It recognises that the demersal fishery is being overfished: *"Total catches in the Artisanal fishery from 2006 to 2016 have declined, on average, from over 4000 to below 3000 tonnes per annum. Declining trends in the CPUE for most demersal species in the last 10 years, high proportion of juveniles in catches, and changes in species composition of catches, are all indicators of unsustainable fishing."*

The overall Goal of the Policy and strategy is:

"to provide effective, efficient, transparent and accountable service delivery through participatory approach to ensure long-term sustainable fisheries and aquaculture management and conservation so that the sector continues to play a key role in the sustainable development of the country and the socio economic well-being of the social one nation."

This Goal logically cascades down to Objectives and then to Policy Statements. The key objective relative to the development of the Coral SAP is:

"Manage fisheries resources through ecosystem based approaches and ensure that policies, legislation and infrastructure development are aligned towards achieving sustainability, taking into account climate change, international commitments and global developments."

The key Policy Statements for reference when developing the Coral SAP are:

Policy 1. Good governance and institutional strengthening - promote fisheries management and aquaculture development based on the ecosystem approach to fisheries, the ecosystems approach to aquaculture, the FAO code of conduct on responsible fishing.

Policy 2. Sustainable management of fisheries and climate resilience - Recognising the importance of the fishery sector to the Seychelles economy, the government will make a more concerted effort to properly manage its fisheries. Fisheries will be made more resilient to climate change by the incorporation of adaptation and mitigation measures within fisheries management.

If strong measures are not undertaken to regulate fisheries, the fishing effort, and address some of the spatial and biological issues that exist, the stocks will continue to decline at a faster rate and to a greater extent in the next 10 years compared to the last decade, and severely threaten the stable price of fish, the viability of fishing operations, and the livelihoods of fishers.

Warm water events have previously led to coral bleaching and significant impacts on the small-scale catches. Seychelles must monitor and seek to understand these events so that its second major pillar of the economy can adapt to and mitigate the changes. Therefore the government will:

- Adhere to principles of co-management, the ecosystem approach to fisheries, the precautionary approach and international best practice within management plans.

- Manage the fisheries subsectors with a view to incorporate eco-labelling and certification so as to ensure stock sustainability and subsector economic viability.
- Undertake an assessment of the vulnerability of the fishery sector to climate change and adaptation measures that may be possible.
- Encourage the development of a select set of long-term indicators that would monitor the climate change impacts within the fishery sector.

Policy 8: strengthening monitoring, control and surveillance - the activities of small-scale fishing vessels are not properly monitored. Enforcement of laws and regulations is still weak and requires further improvement and capacity strengthening [including]:

- Improve surveillance and control operations to cover all fleet segments including small-scale fishery.
- Adopt a national monitoring control and surveillance strategy.

Seychelles Blue Economy Strategic Policy Framework and Roadmap (2018-2030) (GoS/ComSec 2018).

Seychelles Blue Economy Strategic Framework and Roadmap (the Blue Economy Roadmap), was approved by the Government on the 31st January 2018. It is intended to be an integrated approach to ocean based sustainable development bringing together economy, environment and society, consistent with the Sustainable Development Agenda 2030, Aichi Target 11 of the Convention on Biological Diversity (CBD) and the Paris Agreement on Climate Change (2015).

Its Vision is:

> *"To develop a blue economy as a means of realizing the nation's development potential through innovation, knowledge-led approach, being mindful of the need to conserve the integrity of the Seychelles marine environment and heritage for present and future generations."*

And it integrates 4 key pillars:

- Economic diversification & resilience - to reduce economic vulnerability and reliance on a small number of sectors and to increase the % GDP derived from marine sectors.
- Shared prosperity – Creation of high value jobs and local investment opportunities;
- Food security and well-being;
- Integrity of habitats and ecosystem services, sustainable use, and climate resilience.

Strategic Priority 3 “Securing healthy and productive oceans” seeks to inter alia:

- Ensuring ecosystem service accounting is built into economic measures such as GDP;
- Protecting marine & coastal assets, e.g. through marine protected areas (MPAs) and addressing ocean risks (e.g. marine pollution, climate and ocean acidification);
- Implementing blue economy/ocean climate resilience through mitigation (i.e. blue carbon, renewable energy) and adaptation strategies consistent with obligations under the United Nations Framework Convention on Climate Change (UNFCCC).

Results sought by the roadmap include:

- Increased investment in diversification of existing ocean-based economic sectors (particularly fisheries, tourism and ports) to realise greater value and efficiency from the existing resource base;
- Effective protection of Seychelles ocean space and resources through better coordination across different sectors, application of protective measures and greater use of surveillance and enforcement tools;
- New research, innovation and generation of knowledge about Seychelles’ ocean space, resources and management needs.

These four National Policy and strategic documents provide a sound basis and previously stakeholder agreed and Government approved reference points from which to develop a comprehensive Strategy and Action Plan for Coral reefs in Seychelles.

Table 7. National Policy/Strategic Documents Peripheral to Coral and Coral Reef Management	
Policy/Strategy	**Comments and Assessment**
Seychelles National Development Strategy (NDS) 2019-2023 (GoS 2018)	The NDS has replaced the SSDS and previous EMPSs as the country's primary strategic development document. It is however very much framed in the development context. It seeks to pursue sustainable development but talks of the environment in the context of its importance as a resource base to support tourism and fisheries. There are no specific programmes to address biodiversity, let alone coral reefs. It is thus fair to conclude that the NDS is too general, beyond espousing sustainable development, to be of direct relevance to the development of the Coral Reef SAP. This logically directs us back to the NBSAP as the primary national biodiversity oriented strategic document.
Seychelles Coastal Management Plan (2019-2024 (IBRD/MACCE 2019)	The CMP aims to help maintain and protect the coastal zone to reduce coastal risk, support healthy ecosystems, and enable sustainable coastal economic development. It primarily views coral reefs as natural infrastructure that protect coastlines by attenuating wave energy, particularly when they are healthy: *"Several factors affect how effective reefs are in reducing wave energy and thus protecting the coastline: reef type, height of reef crest and water depth, reef morphology, and reef surface roughness. These parameters are related to the health of the coral reef, and their degradation can affect the coastal protection they provide."* It identifies "natural" and anthropogenic stressors that threaten coastal reef health and the protection they offer: *"• natural factors include thermal stress and bleaching, biological diseases and impact from storms.* *• anthropogenic factors include dredging channels, vessel groundings; mooring that fractures coral skeletons; coral mining, sediment and water pollution; and overfishing,* *• Provide for: fisheries and tourism, coastal protection, geological processes and aesthetic wonder."*
Fisheries Comprehensive Plan (MoF 2019)	Basically a strategic business and operations plan for the fishery, with recommendations for revision of the Fisheries Act (which is currently ongoing). It does recognise that there is an issue of overfishing in the artisanal fishery: *"However, even with the greater fishing efficiency of whalers and schooners the catches over the period 1993 to 2016 have dropped significantly from around 5,000 MT to 2,500 MT per annum".*
Mahé Plateau trap and line fishery co-management plan (GoS 2020b).	The area of the plan encompasses the entire Mahé plateau and its deep water slopes as defined and described in zone one of the Fisheries Act and regulations 1991 and revised in 2010. It sets minimum size limits for two key species and bag limits for different classifications of activity, whilst recognising the measures proposed fall short of what is needed, but states the intention of upgrading measures in its second phase.

	The plan falls well short of the standards set in the Seychelles Fisheries Sector Policy and Strategy Document in terms of best practice, good science, an ecosystem approach to fishery management and the application of the precautionary principle. It offers little in its current form to coral and coral reef conservation and management.
Protected Area Policy (GoS 2013)	The Policy Vision is: *"To have a Protected Areas System on land and in the sea that protects and conserves high quality, comprehensive and ecologically representative examples of the Seychelles' natural diversity and cultural heritage and that provides ample opportunities for the fair and equitable sharing of the benefits arising from the sustainable use of these resources."* It sought the updating of Seychelles PA legislation in line with international best practice which is being addressed under the NRC Bill. Its objectives include: • *Create conditions to effectively conserve 50% of national terrestrial areas and effectively conserve and manage 20% of marine area within the EEZ;* • *Maintain and enhance terrestrial and marine ecosystems to guarantee long term ecosystem services;* • *Minimise and mitigate the impacts of climate change by maintaining the integrity and functions of ecosystems;* It is apparent therefore that with regard to coral and coral reefs it has been superseded by the Marine Spatial Plan Initiative.
Seychelles Wetlands Policy and Action Plan 2019-2022 (GoS 2019a)	*Despite indicating otherwise in its scope the actual Action Plan for Wetlands does not adhere to the full definition of Wetland under the Ramsar Convention. It rather defines wetlands as follows:* *"Wetland means an area of mangrove, marsh, swamp or water (including springs, rivulets and rivers and constructed wetlands), which are permanent or temporarily submerged under fresh, brackish or salt water that is static or flowing, including areas of marine habitat to the full extent of the intertidal zone.".* *Therefore tidal reef flats are covered by the action plan, but not reefs in water "the depth of which at low tide does not exceed six metres" as set out in the Ramsar Convention. It furthermore thus only covers a portion of wetlands as defined by the 2016 Environment Protection Act. It otherwise bases its reef flat content on that set out in the NBSAP.* *It can be concluded therefore that wetlands Policy has no substantive relevance to the development of the Coral SAP except for its consideration of tidal reef flats, in which aspect it duplicates the provisions of the NBSAP. This logically directs us back to the NBSAP as the primary national biodiversity document.*
National Plan of Action for the Conservation and Management of Sharks (NPOA) 2016-2020 (SFA 2016b)	*The NPOA is supportive of coral reef management and conservation in so much as its:* • *Vision statement includes reference to sharks being able to fulfil their ecological role – known for various species to support reef resilience.* • *Mission Statement states "critical habitats are managed such that shark populations are in recovery" – coral reefs constitute critical habitat for diverse elasmobranch species.* • *Strategic objectives and work programmes explicitly support and advance: i) the identification and protection of critical habitats, and ii) the protection of biodiversity and ecosystem structure and function.*

Seychelles Tourism Masterplan -Destination 2023 (MTCAPM 2018)	The Masterplan is supportive of coral reef management and conservation in so much as it seeks to: • diversify ecotourism activities: "Over the period covered by this strategy, the focus of the annual marketing plans should shift from sea-sand and-sun holidays to eco-, marine-based and cultural tourism," and it recognises coral reefs as a key component of marine tourism activities (snorkelling, diving, boat based fishing wildlife watching, kayaking etc…) • address anchor damage: "yachts dropping anchor outside mooring zones thereby causing damage to corals. There is therefore a need for appropriate regulations to set clear demarcations as to which activities can be carried and where they can be carried out." • develop "a clear marine-based tourism strategy"
Seychelles recreational Diving Policy (MTCAPM 2015)	The Policy is supportive of coral reef conservation in so much as it states: • "All diving businesses are required to meet the minimum standards of the regulatory bodies and sensitize their clients on the need to preserve the environment and respect the laws that are in place." • "It should be the responsibility of the diving business to sensitize its clients on the need to respect the environment and abide to the rules and regulations that govern the activities they are involved in."
Seychelles Yachting Policy (STB 2008)	The Policy is supportive of coral reef conservation and broader environmental protection in so much as it states: • "Environmental actions shall be undertaken to minimise the impact of an increased level of yachting tourism activity." • "The exercise to install mooring buoys in designated and highly frequented areas shall be accelerated'. • 'Government through the Department of Environment shall explore the possibilities and measures for the mitigation of environmental impacts of the yachting industry. Related facilities and legislations shall be developed thereof".
Seychelles' National Climate Change Policy (GoS 2020c)	The document's vision is: *"A sustainable, climate resilient and low-carbon Seychelles." The overall Objective is: "To facilitate a coordinated, coherent, proactive and effective response to the local, regional and global challenges and opportunities presented by Climate Change."* A very broad general document. It sets out guiding principles including the: Precautionary principle and the objective of sustainable development. It notes in its descriptive text the vulnerability of coral reefs but does not expand on this, and does not address them specifically in its subsequent objectives and commitments. Indeed it appears that a logical framework approach was not utilised in the conceptualisation of this document as various issues and obligations raised are not subsequently addressed under its specific objectives. For example, it notes the need for and states the policy envisages establishing a framework for data [pertaining to climate change] management and collection across all sectors, but this is not latterly addressed under the objectives. It does however include a catch all objective of:

	To mainstream and integrate Climate Change considerations into all relevant sectors and all levels of government". Furthermore Objective 5: "To put in place measures to adapt, build resilience and minimize vulnerability to the impacts of Climate Change" includes a commitment to rehabilitate inter alia "coastal and marine ecosystems". The general nature of the document therefore refers us back to the documents of direct relevance covered prior to this table.
Seychelles National Climate Strategy and Action Plan (NCCC 2009)	The strategy recognises that *"Climate change is likely to heavily impact coral reefs, fisheries and other marine-based resources"*, and that "severe degradation of coral reef habitat [in Seychelles] occurred in the wake of the 1998 coral bleaching event". But then downplays the importance of coral reefs by stating: "*coral reef fisheries are of relatively minor importance in value and volume compared to the demersal line fishery based on the extensive banks of Seychelles"*. It does however incorporate some key actions that support coral and coral reef conservation: Action 1.1.6. *Identify climate sensitivity and develop relevant ecological and socio-economic indicators for the artisanal fisheries subsector.* Action 1.2.8. *Develop ecosystem modelling for climate-sensitive fisheries.* Action 1.3.6. *Implement fisheries-independent monitoring system for coral reef fisheries resources that incorporates resilience indicators.* Action 2.2.8. *Develop social and ecological resilience in exploited marine ecosystems through adoption of an ecosystem-approach in fisheries management plans.* Action 2.3.5. *Enhance the management of coral refugia and resilient areas.*
Intended Nationally Determined Contribution (GoS 2015)	The 2015 INDC seeks to reduce Seychelles' GHG gas emissions by 29%, from baseline, by 2030 – a target not considered particularly ambitious by commentators. It furthermore notes that *"emissions from Seychelles constitute less than 0.003% of global emissions"*. Its Vulnerability/Resilience profile exercise for Seychelles revealed *"Seychelles was most vulnerable and least resilient in terms of biodiversity resources and sustainable consumption and production (both with significant implications for climate change adaptation) the tourism industry (the country's crucial economic sector) and food security, Other areas of concern were sea level rise, coastal and marine resources, water security and energy security."* It recommends for increased resilience for biodiversity that the NBSAP should be fully implemented and biodiversity law fully enforced. It also notes: *"that little research has been done regarding the impacts of climate change on Seychelles' fisheries, both industrial and artisanal, and more research will provide valuable insights to guide adaptation strategies for the fishing sector"* and hence concludes that more research is needed in this regard.

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