REGIONAL FRAMEWORK FOR ECOSYSTEM MONITORING IN THE WESTERN INDIAN OCEAN

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GLOSSARY OF ACRONYMS

ASCLME - Agulhas and Somalian Current Large Marine Ecosystem

ABNJ - Areas Beyond National Jurisdiction

AT - Aichi Target

EMPs - Ecosystem monitoring programmes

EOV - Essential Ocean Variable – Global Ocean Observing system

FARI - Forum for Academic and Research Institutes

GBF - Global Biodiversity Framework

LME - Large Marine Ecosystem

MAC - Main areas of concern

MEDAs - National Marine Ecosystem Diagnostic

SAPs - Strategic Action Programmes

SDGs - Sustainable Development Goals

TDAs - Transboundary Diagnostic Analyses

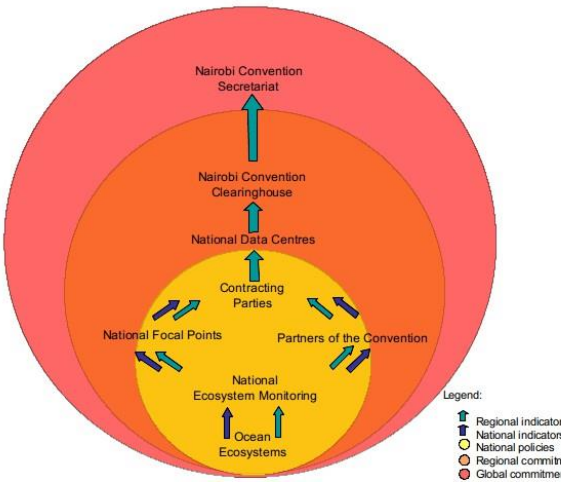
WIO - Western Indian Ocean

WIO-LaB - Addressing land-based Activities in the Western Indian Ocean

Executive summary

"*The Regional Framework for Ecosystem Monitoring in the Western Indian Ocean*" has been developed as a guideline for the Contracting Parties of the Nairobi Convention and partners that are currently implementing the Strategic Action Programmes (SAPs), which were developed by the predecessors of the SAPPHIRE (ASCLME/SWIOFP) and WIOSAP (WIO-LaB) Projects. It aims to provide a standardized approach on the development of national activities to support ecosystem monitoring in the region.

The framework encourages the development and review of long-term monitoring programmes through integrated, coordinated, collaborative and effective partnership across the Western Indian Ocean region (see the figure below). It has been designed in line with the 2030 Agenda and the Sustainable Development Goals (SDG), the post 2020 Global Biodiversity Framework and it is also directly linked to the Step 2 of the UN Decade of Ocean Science for Sustainable Development "*the generation of the data, information and knowledge for the development of a comprehensive understanding of the ocean, its components and its interactions"*. Relevant priority issues and concerns identified in the regional Transboundary Diagnostic Analysis (TDA) were also considered for incorporation into National Planning. This analysis resulted in the selection of ecosystem indicators, included in this framework, to assist the Contracting Parties in addressing these issues and leading their strategies to target their commitments to global and regional initiatives on the conservation of biodiversity, sustainable blue economy and human development.



Ecosystem monitoring is a tool to assess the status and trends of both ecosystem health and

management blueprints over long periods of time. Monitoring of ecosystems is undertaken through continuous and long-term data collection of regional and national indicators that are relevant to evaluate the environmental status and trends, and sustainable ecosystem services usage. Harmonization of methodologies for data collection and standardization of reporting data are key to an efficient regional monitoring.

This framework highlights how the Convention may assist with National Planning on ocean monitoring, includes a step-by-step methodology to the design and implementation of national ecosystem monitoring, and provide suggestions on how national reporting should be conducted through the Nairobi Convention Clearinghouse Mechanism. It also provides a list of 30 priority indicators that should be incorporated into the national efforts and whose data should feed into reporting.

Finally, recommendations are provided to consolidate the importance of synchronized and efficient initiatives nationally and regionally for promoting and uplifting of the economic, cultural and social potential of coastal communities and ecosystem services of the Western Indian Ocean.

1. Rationale

The Western Indian Ocean (WIO) Region comprises the Agulhas and Somalian Current Large Marine Ecosystem (LME) and the recently recognized Mascarene Plateau LME. It incorporates the coastal waters and currents, management and governance boundaries that are adjacent to the continent from Somalia to south-east South Africa (15,000 km extension) sharing cultural, political and biological history. The region has unique biodiversity and abundance of natural resources of socio-economic relevance for the local communities and national economies. Coral reefs, seagrass meadows, rocky shores, estuaries and sand dunes are some of the habitats that provide ecosystem services for activities such as coastal agriculture, mining and energy, maritime trade, fisheries and tourism.

Ecosystem health determines the sustainability and productivity of these activities to support human well-being and, thus, rely on the successful management of the Ocean. Regional ecosystem monitoring provides a tool to assess the status and trends of both ecosystem health and management blueprints over long periods of time. Monitoring of ecosystems is undertaken through constant and long-term data collection of regional and national indicators relevant to evaluate the environmental status and trends, and sustainable ecosystem services usage (CSIR, 2009). It represents a proactive, dynamic and adaptive process which is continuously under review and refinement in terms of the procedures, tools, methods, and approaches used. Thus, it is based on the adaptive management principle (WRC, 2016). Difficulties in aggregating available data from several countries may be minimized by setting up a standardized framework for the contextualization, design, implementation and reporting processes of ecosystem monitoring. Certainly, ensuring that all generated data are fully reproducible, integrated, comparable and accessible will provide a big picture of the trends and changes in the Western Indian Ocean.

Monitoring is an essential component of decision making, because it allows evaluation of the effectiveness of management actions through time and thus reduce uncertainty. Monitoring also helps to determine new threats and issues that may arise through time, as well as to re-prioritize threats and issues. Continuity, consistency, appropriate scale, expertise and effort are central to monitoring (Biber, 2013). It is therefore expected that conducting effective monitoring can be a challenging task, especially in areas with limited human and financial capacity. Institutional continuity is needed from public and private institutions to undertake long-term monitoring and ensure that consistent methods are used through time. Scale considerations are also

key since there is usually a mismatch between the jurisdictional scales of an institution's mandate and the scale needed to conduct effective monitoring. An additional challenge can be the lack of uptake of the collected data by management agencies to inform the decision-making process (Addison et al., 2015; Cvitanovic et al., 2014).

The Contracting Parties to the Nairobi Convention, one of the 18 United Nations Environment Programme's Regional Seas Programmes, have committed under Article 15 (on Scientific and Technical Cooperation) of the Amended Convention to cooperate in scientific research, monitoring and the exchange of data and information in relation to the Convention and its Protocols. The Contracting Parties and partners are currently implementing the Strategic Action Programmes (SAPs) developed by the predecessors of the SAPPHIRE (ASCLME/SWIOFP) and WIOSAP (WIO-LaB) Projects. Both projects identified the need to establish and implement a regional monitoring framework for critical habitats, coasts and shorelines in the WIO region including inshore, offshore, and Areas Beyond National Jurisdiction (ABNJ) to guide countries in national monitoring and assist them in addressing their regional and global commitments. Some of the global commitments include those under the 2030 Agenda for Sustainable Development, and the Convention on Biological Diversity. It is thus key that "*The Regional Framework for Ecosystem Monitoring in the Western Indian Ocean*" takes into account their obligations as well as the most relevant issues for the region. The regional framework for ecosystem monitoring should be considered as a guide to support contracting parties and the region to assess their efforts and progress in achieving regional and global conventions and commitments. This framework aims to provide guideline on how to collect and analyze relevant data to improve the reporting of information at both the national and regional levels while ensuring that the production of data on relevant indicators is comparable across the region. It is also expected that the regional framework will guide Contracting Parties in the formulation and/or review and implementation of their national level monitoring programmes.

The regional framework is developed in line with the 2030 Agenda and the Sustainable Development Goals (SDG), the post 2020 Global Biodiversity Framework and it is also directly linked to the Step 2 of the UN Decade of Ocean Science for Sustainable Development "*the generation of the data, information and knowledge for the development of a comprehensive understanding of the ocean, its components and its interactions"*.

Ecosystem monitoring programmes (EMPs) should address priority issues in the region as

an attempt to provide data and information on the progress towards these global and regional efforts. Currently, a regional coordinated monitoring programme addressing priority regional issues is not in place, highlighting that there is a need to link and coordinate regional and national ecosystem monitoring through a pragmatic and agreed Regional Framework.

2. Purpose and contextualization of the Regional Framework

A. Aim of the WIOLME Framework

The aim of this framework is to provide guidance to the WIO Contracting Parties on the development of activities to support ecosystem monitoring at the national level. These activities will provide basic scientific-based information and knowledge to current regional and global commitments in order to support their obligations and assist with decision making. The framework is not a prescriptive proposal and is to be used for guidance purposes.

This regional framework provides a standardized approach to support contracting parties in national planning, and to design and implement national EMP through a common methodology as well as a guideline for the reporting and communication of monitoring data that are relevant at a regional level.

B. Ecosystem challenges in the Western Indian Ocean region

Coastal and ocean ecosystems of the WIO region face particular issues which were identified at the national and regional levels through the National Marine Ecosystem (MEDAs) and Transboundary Diagnostic Analyses (TDAs) undertaken by the ASCLME-SWIOFP and WIO-Lab projects. These issues have direct impacts in the supporting, provisioning, regulating and cultural services that are key to the socio-economic development of the region and contracting parties as well as to the ocean's health.

The TDAs identified 21 priority issues (Table 1) for the region through a process of prioritization and validation at a national and regional levels that highlighted some challenges in the region. These priorities are grouped in four main areas of concern (MAC):

- Water Quality Degradation;
- Habitat and Community Modification;
- Declines in Living Marine Resources;
- Environmental Variability and Extreme Events.

These issues are of major relevance for the WIO region in terms of monitoring and the development of national EMPs as they serve as the baseline for setting up the ecosystem monitoring programme objectives. Due to the specificity of each Contracting Party, these transboundary priority issues do not have the same level of importance in each country and thus some issues may or may not be incorporated into national EMPs if not relevant or of low priority. Six issues identified as priority at national but not regional levels and vice-versa will be considered in national monitoring: 1.3.4 Suspended solids, 1.3.6 Oil spills, 2.3.2 Seagrass habitats, 2.6 Introduction of exotic non-native species, 3.1.4, Sea turtles, and 3.2.3 Small pelagics. These issues are considered in the situational assessment below and in Annex 1 where national monitoring is discussed. Regional priority issues that may not be relevant to national level should still be incorporated into national activities as a commitment to regional monitoring.

Priority regional indicators were selected in line with national, regional and global targets such as the Sustainable Development Goals, the draft post 2020 Global Biodiversity Framework, its alignment with the aims of the Ocean Decade implementation plan and the Regional Seas Strategic Directive 2017-2020, as well as their relevance and link to the Transboundary Diagnostic Analysis. These 30 indicators are proposed here for consideration by the Contracting Parties (Table 1). Detailed information on the indicator selection process and criteria can be found in step 4 of the "*Guideline for the development of National EMPs (Annex 2) in the Western Indian Ocean*" and the attached excel spreadsheet.

Table 1. High priority transboundary issues in the WIO region, their rating at national levels and selected priority indicators. Abbreviations: H: high; M: medium; L: low; N: not related. National high priority issues are highlighted in grey (modified from ASCLME/SWIOFP 2012). SDG= Sustainable Development Goals, AT= Aichi Target, GBF= Global Biodiversity Framework and EOV= Essential Ocean Variable – Global Ocean Observing system

Main Area of Concern	Issue No	Issue category	Comoros	Kenya	Madagascar	Mauritius	Mozambique	Seychelles	Somalia	South Africa	Tanzania	No.	Priority Indicators
MAC01 Water Quality Degradation	1.1	alteration of natural river flow and changes in freshwater input and sediment load	H	H	H	L	H	M	M	H	H	1	SDG 6.3.2, GBF 10.3 Proportion of bodies of water with good ambient water quality
	1.2	degradation of ground surface water quality	H	H	H	L	H	M	M	H	H	2	SDG 6.3.1 Proportion of domestic and industrial wastewater flows safely treated
	1.3.1	microbiological contamination from land-based and marine sources	M	M	H	L	M	M	L	H	M	3	SDG 14.1.1 Index of coastal eutrophication and plastic debris density
	1.3.5	solid wastes/marine debris from shipping and land-based-sources	H	H	H	L	H	M	H	M	H	4	SDG 6.5.1 Degree of integrated water resources management
	1.3.6	oil spills (drilling, exploitation, transport, processing, storage, shipping)	H	H	H	M	H	L	H	H	M		
MAC02 Habitat and Community Modification	2.1	shoreline change due to modification, land reclamation and coastal erosion	M	H	H	H	H	H	L	M	H	5	GBF 2.3 Proportion of terrestrial, freshwater and marine ecological regions which are conserved by PAs or OECMs
	2.2.1	disturbance, damage and loss of upland watershed	H	H	H	M	H	NR	H	H	H	6	GBF 1.2. Trend in mangrove extent

		habitats (>10m elevation)										7	Mangrove cover and composition (EOV)
	2.2.3	disturbance, damage and loss of coastal vegetation and flood plan habitats (beaches, dunes, coastal vegetation and flood plain habitats to 10 m elevation)	H	H	H	H	H	H	H	H	H	8	Seagrass cover and composition (EOV)
	2.2.6	disturbance, damage and loss of mangrove habitats	L	H	H	H	H	L	H	L	H	9	GBF 1.2 Trend in proportion of live coral cover
	2.3.1	disturbance, damage and loss of coral reef habitats	H	H	H	H	H	H	H	M	H	10	Hard coral cover and composition (EOV)
	2.3.2	disturbance, damage and loss of seagrass habitats	M	H	H	M	H	L	H	L	H	11	SDG 14.5.1, GBF 2.1 Coverage of protected areas in relation to marine areas
	2.3.5	disturbance, damage and loss of deep-water habitats (including sea mounts)	NR	L	H	NR	NR	NR	L	H	H	12	SDG 15.8 Proportion of countries adopting relevant national legislation and adequately resourcing the prevention or control of invasive alien species
	2.6	introduction of exotic non-native species, invasive and nuisance species	L	M	H	M	M	NR	L	H	H	13	AT 11 Management effectiveness of protected areas
MAC03 Declines in Living Marine Resources	3.2.1	decline in populations of sharks and rays	H	H	H	H	H	H	H	H	NR	14	SDG 14.1.1 Proportion of fish stocks within biologically sustainable levels
												15	SDG indicator 14.2.1, GBF 1.1 Number of countries using ecosystem-based approaches to managing marine areas
												16	GBF 1.2, 1.4 Ocean Health Index
	3.2.2	decline in populations of large pelagics	H	M	H	H	H	H	H	L	H	17	AT 6 Estimated fisheries catch and fishing efforts (IPBES core indicator)
												18	AT 6 Number of countries with policies that make adequate provisions to minimize the impacts of fisheries on threatened species
	3.2.3	decline in populations of small pelagics	H	H	H	NR	L	NR	H	L	H	19	AT 6 Number of countries with regulations requiring recovery of depleted species

	3.2.5	decline in populations of reef and demersal fish	H	H	H	H	H	H	H	H	H	20	AT 6 Number of countries with policies to secure that mortalities and significant indirect adverse impacts on non-target species are accounted for
												21	AT 6 Proportion of fisheries with regular monitoring and reporting of impacts on threatened species
	3.3.3	decline in populations of sea cucumbers	H	H	H	H	H	H	H	NR	H	22	AT 6 Proportion of depleted stocks with rebuilding plans in place
												23	AT 18 Number of local community-based monitoring on traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity
	3.3.4	decline in populations of prawns and shrimp	H	H	H	H	M	NR	H	M	H	24	GBF 8.1. Degree of application of a legal/regulatory/policy/institutional framework which recognizes and protects access rights for small-scale fisheries
												25	GBF 4.1, 8.1 Degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing
	3.3.5	decline in populations of lobsters	NR	H	H	H	H	H	H	NR	M	26	Fish abundance and distribution (EOV)
												27	Marine turtles, birds, mammals abundance and distribution (EOV)
	3.4	excessive bycatch and discards	H	H	H	H	H	H	H	M	H	28	Invertebrate abundance and distribution (EOV)
MAC 04 – Unpredictable Environmental Variability and Extreme Events												29	SDG 13.1.2, GBF 7.1 Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030
												30	SDG 13.1.3, GBF 7.1 Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies

C. Regional situational assessment

A situational assessment of ocean ecosystem monitoring in the region (see Annex 1) reveals that monitoring programmes are in place in most Contracting Parties but the coverage of the programmes and level of implementation differ among countries. Those parties with existing monitoring programmes do not support certain regional priority issues and this should be addressed through National Planning during the design and implementation of EMPs and/or when reviewing existing programmes. In other countries of the WIO, national monitoring of the ocean ecosystem's health is either under development or has not yet been incorporated into their national strategies and programmes. National EMPs should incorporate the priority issues of the region in an attempt to provide data and information on the progress towards global and regional commitments, including those related to the Nairobi Convention.

A detailed situational assessment is provided in Annex 1 for each Contracting Party and its linkage to national, regional and global commitments have been made to assist them during planning and implementation of ecosystem monitoring programmes.

3. Structure of the Regional Framework

A. Assistance on National Planning for Ocean EMPs

Each Contracting Party to the Nairobi Convention is committed to the monitoring of ecosystem indicators that are relevant to evaluate the health of the ocean and the environmental management strategies that have been taken place to conserve it in accordance with regional and global commitments. In addition to representatives from relevant national institutions, National Planning should also include the National Focal Points of the Nairobi Convention and national representatives of relevant Networks, Task Forces and Experts/Working Groups set up under the Convention or its projects (e.g. Critical Habitats Task Force, Water Quality Task Force, River Flows Task Force, Expert Group on Marine Litter, Marine Spatial Planning Technical Working Group, WIO Mangrove Network, Coral Reef Task Force, Marine Turtle Task Force, and the Forum for Academic and Research Institutes (FARI)) and partners that have active projects on ocean health or monitoring in the particular country. The Environment and Fisheries departments/ministries will be responsible for obtaining the monitoring data in line with their mandates. The national EMPs will obtain data for regional reporting and incorporation into a long-term regional monitoring process which will be hosted by the Nairobi Convention Secretariat through its Clearing House Mechanism. A list of experts from the contracting parties are provided in Annex 1 to assist with the design, implementation and review of national EMPs.

National Data Centres (under the direction of the respective National Data Coordinators) under the Nairobi Convention will be responsible for the compilation and updating of regionally-relevant monitoring data into the Nairobi Convention Clearing House Mechanism on an annual or bi-annual basis. It is recommended that EMP National Coordinators are established in each National Data Centre in order to facilitate communication and information sharing between the national institutions of the Contracting Parties and the Secretariat. Data and information required from each National Data Centre will be compiled into a standardized reporting template provided in Annex 3 of this framework.

The Secretariat will assess and validate information received from the Contracting Parties and provide the necessary links to regional, continental and global monitoring processes.

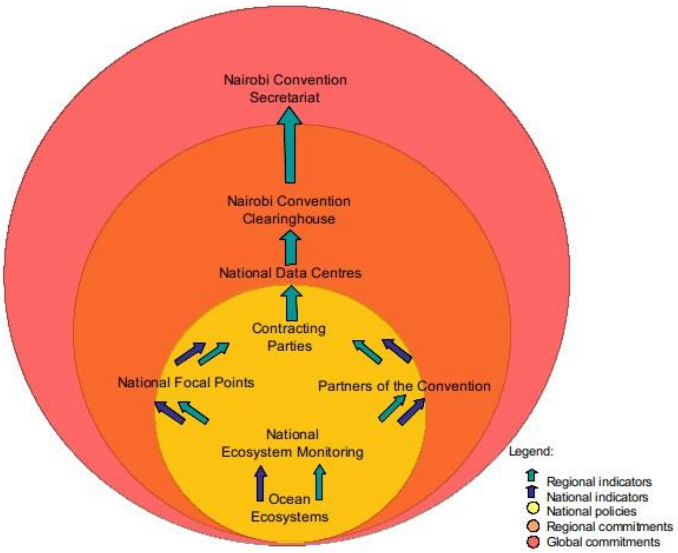


Figure 1. Flow of monitoring data obtained through national ecosystem monitoring programmes and its relationship with national policies, regional and global commitments.

B. Methodology for Ocean Ecosystem Monitoring

National monitoring programmes should be designed and implemented to include the priority issues and needs of the WIO region. A methodology to monitor the selected priority indicators at the national level is provided in full in Annex 2 of this framework. The methodology consists of a detailed step-by-step guideline and its objective is to assist the contracting parties with the design and implementation processes for the development of national ecosystem monitoring programmes as well as its subsequent review and refinement for long-term monitoring. The guideline takes into consideration specific characteristics of the region and each contracting party. A monitoring programme template is given at the end of the Annex 2 to assist the countries with filling out the basic programme steps.

C. Reporting and Communication of Monitoring Data and Information

Monitoring data derived from national EMPs through the analysis of the selected regional ecosystem indicators will be reported for regional monitoring. It is suggested that data and information templates are provided to the national EMP expert/working groups established in each National Data Centre. The common data template should be developed at regional level with agreement on its content and format between countries. An example of the reporting template is presented in Annex 3. It is responsibility of the National Data Centres to compile and update the regional monitoring data into the Nairobi Convention Clearinghouse Mechanism. All regionally-relevant data derived from the national EMPs will be available in the Nairobi Convention Clearinghouse for consultation in decision-making processes and guiding regional initiatives. Reporting frequency of regional monitoring data should be annual or bi-annual even though certain data from indicators may require recurrent monitoring throughout the year.

4. Action Plan

The following actions are proposed for consideration of the Contracting Parties due the implementation of this regional framework:

- National Data Coordinators from the National Data Centres of each Contracting Party will be nominated to oversee implementation.
- National Data Coordinators are responsible to conduct national self-assessments for data reporting on the availability of information for the priority indicators to determine gaps in information and reporting.
- The National Data Coordinators will coordinate the development and implementation of regional indicators and build up capacity required for this purpose. The development and compilation of the Western Indian Ocean State of the Coast Report can be used as an example to inform the procedure.
- National Data Coordinators are also responsible to harmonize data collection methods, ensure comparability nationally and regionally and facilitate data aggregation.
- National Data Coordinators should designate Indicator Coordinators, who will specifically evaluate the indicator data as well as oversee the progress and review the indicator monitoring for quality control and assurance. They will also work closely with expert groups in the Convention such as the marine turtle and coral reef task forces, among others.

5. Challenges and Opportunities

Implementation of EMPs in the WIO region represents a good opportunity for developmental growth in terms of sustainable blue economy as it will provide a long-term overview of the ecosystem's health which supply essential ecosystem services and source of income to coastal communities. It also uplifts scientific research and its development across the region, thus contributing to capacity building. These opportunities are all essential components of the SDGs and Aichi Biodiversity Targets in which the Contracting Parties of the Convention are part of. Commitments to these targets guarantee that financial investments in national sectors of development are accurate and objective. Absence or weakness of EMPs may contribute to wastage of resources that have been allocated to remediate and restore environmental damages, impacts and changes in the marine habitats as these disturbances will continuously occur throughout time if their causes are not well understood and the specific pinpoints detected through monitoring.

The same is applied if some of the most common challenges to the implementation of EMPs are not acknowledged such as: cost of implementation and long-term monitoring; inadequate legal framework; lack of political will and interest; lack of coordination, cooperation and communication among institutions; limited institutional, human and financial capacity to implement, maintain and monitor; technical limitations (e.g. lack of specific equipment to conduct the monitoring, etc); and legal and cultural limitations.

These challenges are of particularly importance in countries of the WIO region due to limitations in the financial and human capacity in most governmental institutions, thus highlighting the significance to develop regional and international partnerships to facilitate implementation. This regional framework represents a relevant step towards integrating and coordinating regional monitoring in the WIO, and an opportunity to harmonize data collection and reporting across the region. This framework will assist countries in the region to assess progress towards the SDG and Aichi Targets by prioritizing the most relevant indicators based on the region's issues and available information. The framework will provide guidelines to developing realistic plans to ensure the production of data as well as updating and monitoring of the ecosystem indicators.

6. Conclusion and Recommendations

The Regional Framework on Ecosystem Monitoring for the Western Indian Ocean provided here comprises a standard approach to the Contracting Parties of the Nairobi Convention on

the development of activities to support ecosystem monitoring at the national level. It attempts to assist them in assessing their efforts and progress to achieve regional and global commitments, including the Sustainable Development Goals, the draft post 2020 Global Biodiversity Framework, the Ocean Decade implementation plan, and the Regional Seas Strategic Directive 2017-2020. The framework is structured to guide the Contracting Parties in coordinating, planning, implementing, integrating and reporting of national data of ecosystem indicators to be fed into the long-term WIOLME monitoring. This will be updated regularly by the National Data Centres of each Contracting Party through the Nairobi Clearinghouse Mechanism.

Thirty priority regional indicators have been selected in this framework and are in line with the issues and concerns identified in the Transboundary Diagnostic Analysis of the Western Indian Ocean region. It is suggested that National Planning incorporate these regional issues and concerns during the design and implementation of EMPs and/or when reviewing existing monitoring programmes. The priority indicators suggested in this framework will be used for reporting of relevant data on the ocean's ecosystem health and environmental management strategies. Reporting of monitoring data will help to oversee gaps in scientific-based information on ecosystem indicators, identify challenges in capacity for monitoring as well as help in the decision-making processes and guiding regional initiatives and obligations.

Compilation of monitoring data from national EMPs is imperative to estimate regional indicators that are required for regional, continental and global commitments on conservation of biodiversity, sustainable blue economy and development in an accurately and objective manner through national and regional investments.

To effectively implement the WIO Ecosystem Monitoring Framework, the following actions are recommended:

- All Contracting Parties should approve and incorporate this framework in their Strategic Action Programmes.
- Each National Party of the Convention should review the situational assessment provided under Annex 1 of this document and update it accordingly by adding relevant information on ocean ecosystem monitoring.
- The priority indicators suggested in this framework should be evaluated, discussed and approved by the Contracting Parties in a dedicated regional meeting in order to standardize data gathering for the regional monitoring.
- The format, content and layout of the reporting template provided under Annex 3 should be discussed and agreed across the Contracting Parties before national monitoring

implementation.

- Specific methodology and parameters to be collected for each of the priority indicators should be discussed with the responsible Indicator Coordinator and Expert Groups together with the National Data Coordinators of the Convention for regional standardization, continuous updating and evaluation of data.

7. References

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Annex I. Situational assessment of the Western Indian Ocean region

December 2020

CONTENTS LIST

EXECUTIVE SUMMARY

Ecosystem health determines the sustainability and productivity of ecosystem services to support human well-being and, thus, rely on the successful management of the Ocean. Regional ecosystem monitoring provides a tool to assess the status and trends of both ecosystem health and management blueprints over long periods of time. Monitoring of ecosystems represents a proactive, dynamic and adaptive process which is continuously under review and refinement in terms of the procedures, tools, methods, and approaches used.

The Contracting Parties to the Nairobi Convention have committed to cooperate in scientific research, monitoring and the exchange of data and information in relation to the Convention and its Protocols. The Contracting Parties and partners are currently implementing the Strategic Action Programmes (SAPs) developed by the predecessors of the SAPPHIRE (ASCLME/SWIOFP) and WIOSAP (WIO-LaB) Projects. Both projects identified the need to establish and implement a regional monitoring framework to guide countries in national monitoring and assist them in addressing their regional and global commitments.

Ecosystem monitoring programmes (EMPs) should address priority issues in the region as an attempt to provide data and information on the progress towards these global and regional efforts. Currently, a regional coordinated monitoring programme addressing priority regional issues is not in place, highlighting that there is a need to link and coordinate regional and national ecosystem monitoring through a pragmatic and agreed Regional Framework. The information in this document is based on a literature review of monitoring programmes and priority issues on the WIO countries and aims to provide an overview of the national and regional issues, as well as their progress on reporting and implementing and addressing their global and regional commitments.

1 Introduction

The Strategic Action Programme (SAP) developed by the participating countries (Comoros, France, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, South Africa, Tanzania) to the project on 'Addressing land-based activities in the Western Indian Ocean' (WIO-LaB) identified the need for a regional monitoring and evaluation plan to be established and implemented for critical habitats, coasts and shorelines. Similarly, the same countries, through the South West Indian Ocean Fisheries (SWIOFP) and Agulhas and Somali Current Large Marine Ecosystems (ASCLME) Projects identified an Ecosystem Monitoring Programme as a key priority during the implementation of the SWIOFP/ASCLME SAP.

Due to the joint execution of the project on 'Implementation of the Strategic Action Programme for protection of the Western Indian Ocean from land-based sources and activities' (WIOSAP) and the 'Strategic Action Programme Policy Harmonization and Institutional Reforms' (SAPPHIRE) Project by the Nairobi Convention within the same countries of the Western Indian Ocean region, it makes good sense for a single integrated ecosystem monitoring framework to be developed for the Western Indian Ocean region, to monitor the LMEs across all areas, including inshore, offshore, and Areas Beyond National Jurisdiction (ABNJ).

It would be necessary for the framework to consider the needs of every participating country in the region, including their respective capacities and strengths, their national monitoring programmes and their obligations under regional and global commitments such as those to the Convention on Biological Diversity and the Sustainable Development Goals.

NGOs such as World Wide Fund for Nature (WWF), Blue Ventures, Conservation International and Coastal Oceans Research Development-Indian Ocean (CORDIO) have been involved in a number of initiatives of relevance. Since the capacity and approach to ecosystem monitoring activities differ within the countries of the WIO region, it is important to implement a framework that considers the needs of the countries, their capacity to implement these programs and the feasibility of these monitoring programmes to ensure monitoring continues after the completion of these projects.

Input from ***all*** key stakeholders will be critical to ensure success.

In executing the assignment, the consultant(s) will work closely with Western Indian Ocean Marine Science Association (WIOMSA) and Programme Management Units (PMUs) of the SAPPHIRE and WIOSAP projects.

2 Methods

2.1 Literature review

This included a literature review of existing ecosystem monitoring practices, initiatives and programmes in the countries of the WIO region combined with consultations with stakeholders. Key stakeholders include public authorities in charge of coastal and marine ecosystem conservation and management, communities, associations, academia, NGOs, WIOMSA, representatives from the Nairobi convention. The review also focused on the frameworks and programs' objectives, rationale for establishment, mode of operation, funding in order to identify best

practices and opportunities for synergies in the WIO region.

Table 1. Summary of ecosystem monitoring programs conducted in the Western Indian Ocean Large Marine Ecosystem. N: number of indicators. A copy of this summary was submitted to the stakeholder consultations together with the cover letter and questionnaire.

Name	Scope	Category	N	Example	Frequency	Funding agency
ASCLME/ SWIOFP	WIO	Fisheries	28	Marine Trophic Index (MTI)	monthly-quarterly or annual	GEF/UNDP/UNEP
ASCLME	WIO	Productivity Ecosystem health Water quality and pollution Socio-economics Governance	2 42 8 27 18	 Harmful algal blooms (HABs) Solid waste Fish consumption Number of permit issued	annual hourly, weekly, monthly Per census	GEF/UNDP/UNEP
GMES & Africa Mar-CoSouth	WIO	Productivity	1	Primary productivity	NA	African Union
CSIR WIO-Lab	WIO	Water quality and pollution	5	Trace metals	annual, every six months, every two weeks	GEF/UNDP/UNEP
TWAP	Global	Fisheries Productivity Ecosystem health Socio-economics Governance	9 3 9 13 4	Fishing effort Chlorophyll a Extent of mangrove Tourism revenues Engagement of countries participating in arrangements	NA	GEF/UNDP/UNEP

2.2 Stakeholder consultations

The following table represents a list of stakeholders included in the consultations, which was supplemented in consultation with the project leaders. Stakeholders were consulted by email using the interview template provided in Appendix 1. A summary of the responses to the questionnaire can be found in Appendix 2 below.

Country	Institution	Name	Email

South Africa	IMT	Benita Maritz	Benitam@imt.co.za
	DEFF	Ashley Naidoo	Anaidoo@environment.gov.za
	UCT	Raymond Roman	raymond.roman@uct.ac.za
	IMR	Carl Wainman	ckw@imt.co.za
	CSIR	Stewart Bernard	sbernard@csir.co.za
	SAEON	Juliet Hermes	juliet@saeon.ac.za
Comoros	Centre National de Documentation et de Recherches Scientifiques - CNDRS	Ahmed Abdoulkarim	a_abdoulkarim@yahoo.fr
	Ministry of Fisheries and Env.	Ambadi Issouf	ambadi_issouf@yahoo.fr
	Ministère de l'Energie, de l'Agriculture, de la Pêche et de l'Environnement, Focal Point du PSMA Direction Général des Ressources Halieutequ es	Boina Said	dalaili@live.fr
	Ministère de l'Energie, de l'Agriculture, de la Pêche et de l'Environnement, Projet SWIOFish1-Comores Direction Générale des Ressources Halieutiques	Hassani Abdillah	hasahamada@yahoo.fr
Kenya	KMFRI	Harrison Ong'anda	hochieng2003@gmail.com
	KMFRI	Joseph Kamau	jkamau@kmfri.co.ke
	NEMA	Stephen Katua	skatua@nema.go.ke
	KMFRI	Charles Magori	cmagori@kmfri.co.ke
	State Department for Fisheries, Aquaculture and Blue Economy Kenya Fisheries Services	Lucy Obungu	lucyobungu@yahoo.com
	Department for Fisheries, Aquaculture and Blue Economy Kenya Fisheries Services	Mwaka Said Barabara	barabaraside@gmail.com
Tanzania	TAFIRI	Baraka Kuguru	barakakuguru@tafiri.go.tz barakakuguru@gmail.com
	IMS/UDSM	Margareth Kyewelyanga	maggie@ims.udsm.ac.tz
	IMS/UDSM	Yohanna Shaghude	yohanna.shaghude@gmail.com/ mamakevin@gmail.com

	Ministry of Agriculture, Natural Resources, Livestock and Fisheries	Omar A. Ami Magese E. Bulayi	oamakando@gmail.com/ oama-kando@yahoo.com emmabulayi@gmail.com
	Sokoine University of Agriculture	Johnson Grayson	mshanajohn1@yahoo.com
	Institute of Marine Sciences, U. of Dar es Salaam	Narriman S.Jiddawi	n_jiddawi@yahoo.com
	Tanzanian Fisheries Research Institute	Mary Kishe	mkishe@yahoo.com
Madagascar	WCS	Andriamandimbisoa Razafimpahanana	dimby@wcs.org
	WWF	Remi Ratsimbazafy	rratsimbazafy@wwf.mg
	CNRE	Yves Mong	yves.mong@cnre.mg
Mauritius	Mauritius Met Services	Krisna Bucha	krisnabucha@gmail.com
	MOI	Ruby Moothian Pillay	kamlaruby@intnet.mu
	PM Office	Rezah Badal	mrbadal@govmu.org
	Ministry of Blue Economy, Marine Resources, Fisheries and Shipping	Mr. CONHYE Koosiram	Permanent Secretary
	Ministry of Blue Economy, Marine Resources, Fisheries and Shipping - Albion fisheries research centre	Mrs. KOONJUL	Assistant Director (Fisheries) (Temporary)
Seychelles	SFA	Calvin Gerry	cgerry@sfa.sc
	SFA	Vincent Lucas	vlucas@sfa.sc
Mozambique	Instituto Nacional de Hidrografia e Navegação	Sinibaldo Canhanga	scanhanga@yahoo.com.br
	Eduardo Mondlane	Veronica Dove	dfnica@gmail.com
	Eduardo Mondlane	Antonio Hoguane	hoguane@yahoo.com.br
Somalia	Ministry of Fisheries and Marine Resources	Abdullahi Addow	Mr.addow@gmail.com
	Ministry of Fisheries and Marine Resources	Abdirahman Osman	aosman.mfmr@gmail.com
Regional	IOC-UNESCO Subcommission for Africa	Mika Odido	m.odido@unesco.org
	CORDIO	David Obura	dobura@cordioea.net
	CORDIO/MASPAWIO	James Mbugua	jmbugua@cordioea.net
	COI	Gina Bonne	gina.bonne@coi-ioc.org
	Nairobi Convention	Bonface Mutisya	bonface.mutisya@un.org
	Nairobi Convention	Dixon Waruinge	dixon.waruinge@un.org
	SAPPHIRE/NC	Sinkinesh Jimma	sinikinesh.jimma@un.org
	WIOMSA	Julius Francis	julius@wiomsa.org

	WIOMSA	Arthur Tuda	tuda@wiomsa.org
	Nairobi Convention	Timothy Andrew Marlyn Omondi	Timothy.andrew@un.org marlyn.omondi@un.org
	WIOSAP/NC	Jared Bosire	Jared.bosire@un.org

Gaps and opportunities in the national and regional capacity were identified to establish a realistic monitoring strategy in the region, as well as possible partnerships and collaborations in coastal and marine ecosystem monitoring to develop the WIO ecosystem monitoring framework. The assessment includes examination of the existing national and regional strategies and frameworks as well as monitoring structures, policy provisions, and the science-policy interface in each country and provide an agreed shared vision and goals for greater impact. This allowed us to define the appropriate and effective governance structure and mechanisms for implementation of the monitoring framework.

2.3 Validation workshop

The draft framework will be presented to technical experts for review and validation after the desktop analysis is finalized in February 2021. The Nairobi Convention and WIOMSA will organize the meeting and contact the technical experts to discuss and validate the results of the study. Following the validation workshop, a report detailing the regional ecosystem monitoring framework for the WIO region including recommendations from the expert panel for the next steps will be submitted.

3 Ecosystem monitoring in the WIO region

Initial assessments of the national monitoring programs have started and the data gathered so far is included below, particularly for South Africa, Madagascar and Tanzania. Further data will be incorporated in the next phase once newly available information is assessed for these countries.

3.1 Comoros

The National Marine Ecosystem Diagnostic Analysis (MEDA) identified a number of areas of concern including bleaching, acidification, destructive fishing methods (e.g. dynamite fishing), coral and sand mining, pollution, overfishing, habitat destruction, sea level rise among others (Comoros MEDA Annex I. Areas of Concern). Turtles are affected by a number of factors in Comoros including meat trade, egg poaching, habitat destruction and fishing. Climate change represents an additional threat to marine biodiversity and the coastal area[1].

According to the Voluntary National Report (VNR) for Sustainable Development prepared by the Union of Comoros, important steps have been taken to achieve the implementation of SDG

[1] https://sustainabledevelopment.un.org/content/documents/26404VNR_2020_Comoros_Report.pdf Accessed 18/11/2020

14 in Comoros including the adoption of a Blue Economy strategy aiming to '*promote economic and social development practices that conserve marine and coastal biodiversity*'[1]. The National Protected areas (2017-2021) expansion strategy resulted in the creation of five new protected areas and the strengthening of Mohéli National Park, with the aim of conserving and sustainably using marine and coastal ecosystems.

The Voluntary National Report for Sustainable Development recognizes the following priority issues constraining the implementation of SDG 14:

- persistence of destructive fisheries that threaten the balance of the food web and sustainability of resources fisheries;
- increased pollution of the marine environment through plastics, oil spills and household garbage disposal in the coastal environment;
- the capacity of research and development still very low for developing the country's natural resources.

Monitoring programmes

Fisheries statistics are only available for important fisheries targets such as large pelagic species (e.g. tuna species, dolphinfish), which are managed by the Indian Ocean Tuna Commission (IOTC) (Breuil and Grima, 2014). General assessments of fisheries have been conducted by the government providing an indication of the total number of boats and fishers for the traditional and artisanal fisheries (SWIOFC-IOTC-2014-WoE01-13). The MEDA lists a number of projects underway related to the marine and coastal environment, in which selected projects directly relevant to the fisheries sector are:

- Development of the artisanal fisheries including the development of a database for artisanal fishing and infrastructure for handling and processing of fishery products;
- Southwest Indian Ocean Fisheries project – SWIOFP;
- Project THONIER on monitoring, control and surveillance of large migratory pelagics and fishing activity in the EEZ;
- Project "Improving the legal framework and management of the fisheries sector' aiming to develop the fishing legal framework and a strategic direction for the development of artisanal fisheries;
- Project "Investment plan for the Ministry of Fisheries' aiming to establish infrastructure for marketing of products from fishing and conservation;
- Project 'Monitoring of industrial fishing' aiming to contribute to the management of fishery resources through control and surveillance in territorial waters.

A participatory research programme coordinated by Blue Ventures and the Comorian NGO Dahari started in 2015 at the Sima Peninsula, aiming to '*address the pressures on the marine ecosystems of the Sima peninsula in western Anjouan*'. The project has conducted a comprehensive baseline assessment and the main objective of the ecological assessment is '*to identify key sites for ecosystem monitoring (e.g. coral reefs, mangroves and seagrass beds), and to help select sites for in-depth research (reef surveys, socio-economic assessments and catch monitoring)*' (Freed et al., 2018). Within the Moheli Marine Park, daily monitoring of turtle nesting tracks and attempts takes places on 34 out of the 45 beaches within the MPA since August 2009.

Coral reef monitoring is conducted at the Union of the Comoros, Grande Comore, Anjouan, and Mohéli since 1998 (see Obura et al., 2017, Chapter 2 for details). The project MAREX 12726 is currently underway in Grande-Comore and Anjouan. This project aims to 1) assess

environmental impact on marine ecosystems on specific sites of Grande-Comore and Anjouan, and 2) conduct taxonomic inventories of marine species (Comoros 2020).

Key Institutions

- National Institute for Agriculture, Fisheries and Environment (NIAFE)
- General Directorate of Fishery Resources (Direction Générale des Ressources Halieutiques)
- National Centre for Fisheries Control and Surveillance (Centre National de Contrôle et de Surveillance des Pêches)
- National Syndicate for Fisheries Development in the Comoros (SNDPC – Syndicat National pour le Développement des Pêches aux Comores)
- Community Centred Conservation (C3)
- Maison de l'écotourisme de Mohéli
- Mohéli Marine Park (PMM)
- Association d'Intervention pour le Développement et l'Environnement (AIDE)
- Wildoceans
- Blue Ventures
- The Association for Intervention for Development and the Environment (AIDE)
- Action Comoros
- Laka Lodge, Moheli

3.2 Kenya

The MEDA identified a number of areas of concern including increasing pollution, coastal erosion and accretion, habitat transformation resulting in loss of critical habitats, introduction of invasive species, overfishing, illegal fishing, destructive fishing methods, climate change, limited financial and human capacity and policy, legal and institutional structures for effective management (Kenya MEDA Annex IV Areas of Concern).

The second voluntary national review on the implementation of the Sustainable Development Goals[2] indicates that some of the ongoing strategies implemented by the Kenyan government to conserve and sustainably use the oceans, seas and marine resources for sustainable development include:

- Collaboration with other stakeholders to promote climate change adaptation and mitigation measures on fisheries and aquaculture;
- Promoting local deep-sea fishing companies through joint ventures, reflagging of foreign fishing vessels and chartered fishing vessels;
- Deepening the Blue Economy Strategy;
- The Kenya Coast Guard.

The second VNR indicates that Kenya reports information for a number of indicators for all SDGs. In terms of SDG 14, information is reported for the indicators 14.4.1: Proportion of fish stocks within sustainable levels; 14.5.1: Coverage of protected areas in relation to marine areas;

[2] https://sustainabledevelopment.un.org/content/documents/26360VNR_2020_Kenya_Report.pdf

14.a.1.: Proportion of total research budget allocated to research in the field of marine technology[2].The second VNR also highlights that the development of the blue economy is a key emerging topic, and that a regional institutional framework is needed for collaboration on transboundary water bodies[2]. The VNR prepared by the Civil Society states that the monitoring and mangrove restoration programmes conducted by the World Wide Fund in Kenya has resulted in the rehabilitation of 1.5 acres of degraded mangrove area and a 2% increase in hard coral cover in Kiunga Marine Protected Area (SDGs Kenya Forum, 2020).

The second VNR recognizes the following priority issues and challenges to the implementation of SDG 14:

i. Decline in fish stocks, loss of certain fish populations and loss of cold water fish growing areas and rivers;
ii. Declining fish stock due to overexploitation;
iii. Limited fishing technology for semi-industrial and industrial fisheries in the deep waters;
iv. Low aquaculture development;
v. Insecurity at sea, piracy and gear thefts especially in the transboundary waters.

Monitoring programmes

Fisheries statistics have been collected in Kenya since the early 1970's using a combination of frame and catch assessment surveys (KCDP, 2013). Fisheries data collection was then conducted using total enumeration, this method requires recording all fishing trips at all coastal landing sites (Ndegwa & Geeham, 2017). This method was questioned due to a number of reasons such as the resources needed to conduct the monitoring. Catch assessment surveys (CAS) are used since 2013 for fisheries data collection. Further details on the CAS methodology can be found in Ndegwa & Geeham, 2017.
The MEDA lists a number of projects related to the marine and coastal environment taking place up to 2012. Selected projects directly relevant to the fisheries sector are (Source: Kenya MEDA Annex VII. National Projects):

- Ocean Data and Information Network for Africa (ODINAFRICA-IV)
- South West Indian Ocean Fisheries Project - SWIOFP
- Malindi-Ungwana Bay Fisheries Project
- Development of a catfish & tilapia production
- Natural Geography of Inshore Areas (NaGISA)
- An assessment of the Socioeconomic impacts of Climate-related Environmental degradation on Faza island
- Kenya crustacean component of South West Indian Ocean Fisheries
- Resilience and adaptation of mangroves and dependent communities in the WIO region to the impacts of climate change
- Study of Potential Fishing Zones (PDF) for Tuna (*Thunnus albacores*) in Kenyan EEZ using satellite-based SST and Chlorophyll-a
- Distribution of pathogenic Vibrio cholerae strains in aquatic environments in coastal areas of East Africa: Implication to cholera outbreaks and control
- African Monitoring of the Environment for Sustainable Development
- (AMESD-IOC)
- African Monitoring Environment for Sustainable Development

- Dr Fridjof Nansen Stock Assessment Surveys (Kenya Coast 1982-1985) plus the latest surveys in 2018/2019
- The Monsoon (MONEX) Experiment 1979-Kenya coast
- Coastal Zone Management Phase II (Receptor Binding Assay of Potentially Harmful Algae) - RAF/7/007
- Enhancing Regional Capability For The Assessment Of Contamination In The Marine Environment (RAF/7008)
- Agulhas and Somali Current Large Marine Ecosystem project
- Coral reef mapping and biophysical assessment in Shimoni-Vanga, southern Kenya
- Coral bleaching and mortality during 2010 in two marine national reserves, Kenya
- The reproductive biology and fishery of siganids in south coast, Kenya Project funded by WIOMSA marine research grant.
- Improvement of the living standard of rural communities in Kenya through
- Artemia production in coastal saltworks"
- GEF-Western Indian Ocean Marine Highway Development And Coastal And Marine Contamination Prevention Project, GEF-WIOMHD
- The Nairobi Convention Clearinghouse and Information System (CHM) project
- Development of an Environmental Sensitivity Atlas For The Coastal Area of
- Kenya PHASE II of the National Marine Oil Spill Contingency Plan Kenya

The MEDA provides detailed information on the description of activities, objectives, contact person for each project among other information. The Kenya Marine and Fisheries Research Institute (KMFRI) is involved in several projects currently underway including:

- The 'Larval Fish Production and Dispersal in Critical Habitats of Coastal East Africa' (FLAPSEA) project. This is a collaborative project including researchers from Kenya, Tanzania and Sweden. The project started in March 2019[3] and aims to investigate how food-provisioning services in the form of fish production are threatened by coastal habitat degradation and how production of this natural resource is related to climate change and coastal development in East Africa.

- The AgriFI Kenya Climate Smart Agricultural Productivity Project (CS APP) aims to strengthen productive, climate adapted and market integrated small holder agriculture and aquaculture to reduce national food deficit and improve the sector competitiveness[4].

- The IMAQculate project 'Evaluating Costs and Benefits of Prophylactic Health Products (PHPs) and Novel Alternatives on Smallholder Aquaculture Farmers in Asia and Africa' aims to improve profitability of intensifying smallholder farmers and wider industry reputation and to develop internal capacity to support future research on PHP efficacy, regulation and economic benefit[5].

[3] https://www.kmfri.co.ke/index.php/about-us/research-centres/nairobi-liaison-office/13-news-and-events/201-flapsea-project-emerging-results-from-research-and-academic-collaboration

[4] https://www.kmfri.co.ke/images/pdf/AgriFI-Kenya-CS-APP-BRIEF_amended-1.pdf

[5] https://www.kmfri.co.ke/images/pdf/IMAQulate-Project-brief.pdf

- Assessment of the ecological aspects of microplastic pollution in Dar es Salaam, Zanzibar and Mombasa (MICROMARE, 2018-2021) project aims to quantify the difference in microplastics occurrence and distribution in various aquatic environmental matrices and examine the adsorption of chemicals on microplastics, their ingestion, trophic transfer and chemical release, and a wide array of ecotoxicological effects on invertebrates and vertebrates and to communicate the findings of the project [6].

- The Billfish Interactions, Livelihoods, and Linkages for Fisheries sustainability in the Western Indian Ocean (BILLFISH – WIO) project (2019-2022)[7]. The project activities take place in Kenya, Madagascar, Mozambique, Somalia, South Africa, and Tanzania

- The Enabling Sustainable Exploitation of the Coastal Tuna Species (Kawakawa and Skipjack) in the Western Indian Ocean (2018-2021) project aims to describe the genetic diversity, population structure and connectivity of two commercially important small tuna species, Kawakawa and Skipjack, across the participating countries and relate this to key economic, biological and environmental information to inform management and development of this sector[8]. The project activities take place in Kenya, Mozambique, South Africa, and Tanzania.

- The Slippery resource in peril: Ecology of Western Indian Ocean Anguillid eels and their contribution to sustainable fisheries and livelihood along the East Coast of Africa (2019-2022) project takes place in Kenya, Mozambique and South Africa[9].

- The WIO-BENTH project 'Identification, characterization and vulnerability assessment of benthic ecosystems in the WIO" takes place in Kenya, Madagascar, Mozambique, South Africa, and Tanzania.

Key Institutions mandated with monitoring and implementation

- National Environment Management Authority (NEMA)
- Kenya Fisheries Service
- Kenya Wildlife Service
- Ministry of Environment and Forestry
- Department for Fisheries, Aquaculture and the Blue Economy
- Water Resources Authority
- Kenya Marine and Fisheries Research Institute
- World Wide Fund for Kenya[10]

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[6] https://www.wiomsa.org/ongoing-project/assessment-of-the-ecological-aspects-of-microplastic-pollution-in-dar-es-salaam-zanzibar-and-mombasa-coastal-marine-environments-micromare/

[7] https://www.wiomsa.org/ongoing-project/billfish-interactions-livelihoods-and-linkages-for-fisheries-sustainability-in-the-western-indian-ocean-billfish-wio/

[8] https://www.wiomsa.org/ongoing-project/enabling-sustainable-exploitation-of-the-coastal-tuna-species-kawakawa-and-skipjack-in-the-western-indian-ocean/

[9] https://www.wiomsa.org/ongoing-project/billfish-interactions-livelihoods-and-linkages-for-fisheries-sustainability-in-the-western-indian-ocean-billfish-wio/

[10] https://gcap.global/wp-content/uploads/2020/07/Kenya-2020-CS-VNR.pdf

3.3 Madagascar

The MEDA identified a number of areas of concern including coastal erosion and sedimentation, pollution, water abstraction, ocean warming and acidification, extreme events, destructive fishing methods, coral and sand mining, overfishing, unsustainable mangrove harvesting, coral bleaching, invasive species, among others (Madagascar MEDA Annex IV. Areas of concern).

The VNR on the implementation of the SDGs indicates that Madagascar has already integrated the Sustainable development Agenda 2030 into national development plans and strategies. In terms of SDG 14, an Inter-Institutional Taskforce for the Achievement of Sustainable Development Goal 14 (SDG14) was set up to launch a series of consultations to achieve the implementation of SDG 14. The task force is led by the Ministry of Economy and Planning, in partnership with UNDP and the World Wide Fund For Nature (WWF)[11]. The consultations took place in 2017 and involved the national and local-level bodies concerned with ocean management and conservation, the communities in these coastal zones, private sector partners, and technical and financial partners. The Task Force aims to coordinate and structure the contributions of each stakeholder to this strategic framework, as well as to establish a good governance structure for the achievement of SDG 14.

The VNR recognizes the main challenges to the implementation of the SDGs in Madagascar which includes limited technical and institutional capacities of the various stakeholders to fulfil their respective roles, and limited implementation of public policies and other sovereign functions[12].

Monitoring Programmes

A detailed record of national projects undertaken in coastal zones up to 2012 can be found in the Madagascar MEDA Annex VII. The Directory Plan for Research (PDR) in Marine Sciences was designed in 2018 and developed by the Minister of Higher Education and Research. The plan indicates the current challenges to the ocean ecosystem health in the country, provides a guide of ecosystem indicators related to biological, chemical and physical factors, outlines the application and evaluation of a long-term monitoring of species as a research strategy, and other related information. Ecosystem indicators are provided for specific sites/habitats of priority research: coral reefs, mangroves, beaches, estuaries and river mouths. In line with the PDR in Marine Sciences, the Madagascar National Parks (MNP) developed an ecosystem monitoring programme for implementation in the National Marine Parks called "Ecosystem Monitoring Protocol For Marine Ecosystems". The programme was developed in 2013 as an extension of a previous ecosystem monitoring programme of target animals from environmentally protected areas and launched in 2012, which though did not incorporate the needs of reserves and parks in particular of marine protected areas (MPA's). The programme objective is to provide a standard methodology for the ecosystem monitoring of Malagasy MPA's in order to produce standardized and compatible results, provide information and tools on the ecosystem health through automatization of databases, and generate reliable and valid scientific data for research and publication. This programme was developed according to previously available methodology

[11] https://www.oceanactionhub.org/madagascar-holds-series-national-consultations-sdg-14

[12] https://sustainabledevelopment.un.org/content/documents/10723Madagascar_Final%20Version.pdf

together with stakeholders and experts consultations through workshops. The methods for ecosystem monitoring were applied differently for four main sites/habitats, each one having their particularities (e.g. frequency of monitoring) and needs (e.g. number of sampling replications): Coral Reefs, Mangroves, Marine Turtles, and Herbivorous to Marine Phanerogams (Table 2).

The National Centre for Oceanographic Data of Madagascar (CNDO) under the Institute of Marine Sciences and Living Resources Research (IH.SM) as part of the IODE (International Oceanographic Data Exchange) and ODINAFRICA (Ocean Data and Information Network for Africa) programs has a monitoring programme of oceanographic ecosystems. The data from this programme, however, could not be assessed in the present draft.

Other monitoring programmes include those organized by non-governmental organizations such as Wildlife Conservation Society (WCS) and CETAMADA on cetaceans. WWF Madagascar has an aerial surveillance monitoring programme for mangroves through the Low Enforcement Monitoring - Spatial Monitoring & Reporting Tool (LEM-SMART) in which it detects fire, deforestation or any other threats to the mangrove forests.

Table 2. List of implemented ecosystem indicators gathered from Malagasy monitoring programmes.

Category	**Sourced from**	**Selected site/habitat**	**Indicator**
Environment	PDR/ MNP	Coral reefs	Relative composition of the benthic cover
			Characteristics of the hard coral cover
			Roughness (measurement of the topographic complexity of the reef)
			Fish biodiversity and biomass
			Biomass of sea urchin and sea cucumber
			Frequency of occurrence of target species
			Oxygen rate
			Dissolved inorganic minerals (P, N etc).
		Herbivorous and Marine Phanerogams	pH and salinity
			Number and identification of phanerogams species
			Total cover and relative cover of each species
			Canopy height
			Herbivory behaviour
			Animal abundance
			Presence of flowers, fruits and seeds
		Mangroves	Identification of mature trees (circumference greater than 4cm)
			Circumference at Chest Height (CHP)
			Angle value (horizontal to branch top)
			Tree size

			Abundance and identification of young trees (circumference less than 4cm)
			Abundance of crab burrows
			Abundance of other species of fauna and flora
			Anthropogenic cut stumps
			Identification of pollutants (e.g. hydrocarbons, heavy metals, toxins).

Institutions mandated with monitoring and implementation

- Ministere de l'Enseignement Superieur et de la Recherche Scientifique
- Ministere de l'Environnement
- Service d'Appui à la Gestion de l'Environnement
- Ministere de Transport et de la Meteorologie
- Agence National de la Cartographie
- Centre National de la Recherche Oceanographiques (CNRO)
- Commite National sur la Teledetection
- Ministere de la Peche et des Ressources Halieutiques
- Academic institutions: universities and research institutes
- Conservation bodies: e.g. Madagascar National Parks
- Non-governmental organizations: Wildlife Conservation Society, Blue Ventures, Reef Doctor

3.4 Mauritius

The MEDA identified a number of areas of concern including increasing coastal erosion, sea level rise, marine pollution, ocean acidification, mineral exploration, extreme waves, ocean warming causing coral bleaching, fish kills, overfishing, destructive fishing methods, habitat destruction, among others (Mauritius MEDA Annex IV. Areas of Concern).

The performance audit report on the Preparedness for implementation of the SDGs by the Ministry of Foreign Affairs, Regional Integration and International Trade[13] indicates that a Committee on SDGs comprised by 22 representatives from different Ministries, Departments and Public Entities was set up at Statistics Mauritius in October 2016. This committee coordinates the mechanisms to ensure data sharing among national institutions for SDG reporting. Data is available for 155 indicators, and SDG 3 has the highest data availability while SDG 11, 13 and 16 have more than 50% of data not available (to May 2018)[13]. The Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping (MOEMRFS) and Mauritius Oceanographic Institute are responsible for the SDG 14 indicators, with available information for four out of the 10 SDG 14 indicators.

[13] https://www.intosai.org/fileadmin/downloads/focus_areas/SDGs_and_SAIs/sai_preparedness_audits/SDGs_2019_Mauritius_prep_EN.pdf

The report states the following actions to improve Mauritius preparedness for the implementation of the SDGs:

- Develop a strategic long-term plan;
- Raising awareness of 2030 Agenda;
- Stakeholders engagement;
- Setting up of an Institutional arrangement;
- Mobilisation of financial resources;
- Improving the data framework.

Monitoring Programmes

Catch, effort and fishing positions are recorded in logbooks by both foreign and local fishing vessels unloading at Port Louis, which are submitted to the Port State Control Unit (PSCU) prior to unloading. Submission of logbook is mandatory and commercial vessels are required to use Vessel Monitoring System. Logbook catches are verified against the landing catches recorded by the Fisheries Protection Officers at the port during unloading. Observers programs on foreign and local commercial vessels are undertaken, regular inspections conducted by fisheries officers are performed for the artisanal fisheries since they do not report catches using logbooks.

Mauritius will soon embark on the development of a new software for the input and analysis of tuna data. Mauritius is also in the process of implementing the Electronic Reporting System (ERS) which will enable to receive real time catch data of EU fishing vessels operating in Mauritian waters and on the operations of Mauritius-flagged vessels. Mauritius is already participating in the ePSM programme and will participate in forthcoming IOTC programmes to improve compliance to IOTC management measures related to quality of data.

The Marine Protected Area cover in Mauritius is 7190 hectares (Fourth National Report on the Convention o Biological Diversity 2010). There are six fishing reserves and two marine parks in Mauritius (Blue bay and Balaclava). Mauritius agreed to monitor the development, tourism and fishing activities in the coastal waters of the MPAs as well as take measures to prevent pollution and negative anthropogenic effects.

- The global objective of the Lagon Bleu project is to promote the sustainable management of the marine and coastal zones of Blue Bay and Pointe d'Esny by carrying out sensitisation campaigns for the conservation of marine and coastal biodiversity and traditional fishing practices[14] (Tyler, 2012).
- Coral reef monitoring includes collection of data on coral and benthic cover, fish and invertebrate biodiversity and crown of thorns (COTs) starfish prevalence at study sites in the different islands of Mauritius. 248 stations have been surveyed since 1996, 62 are permanent monitoring stations but only 38 (33 in lagoons and 5 offshore) are regularly monitored over time in Mauritius Island (Obura et al., 2017).
- Hawksbill turtle monitoring in the Blue Bay Marine Protected Area (Chumun et al., 2019[15]).

[14] https://ecosud.mu/wp-content/uploads/2019/09/MauritiusMarineSurveyReport2012.pdf Accessed on 14/11/2020

[15] https://ecosud.mu/wp-content/uploads/2019/09/WIOMSA-_Turtle_2019.pdf Accessed on 14/11/2020

Detailed information on completed and ongoing projects conducted by the Mauritius Oceanographic Institute can be found in their webpage[16].A list of ongoing projects can be found below:

- Mapping of oceanic and coastal environments of the Republic of Mauritius; Component - Ecological survey (incl. bleaching assessment) of nearshore waters of Mauritius
- Biological Survey of Port Mathurin Harbour to Detect Introduced Species
- Ships' Biofouling in Port Louis Harbour
- Assessment of living resources in the EEZ of Mauritius
- Mapping of oceanic and coastal environments of the Republic of Mauritius; Component - Plankton assessments in the EEZ of Mauritius including outer islands (Seamounts and FADs)
- Mapping of oceanic and coastal environments of the Republic of Mauritius: Component - Multidisciplinary survey of Agaléga islands
- Community based coral culture in the Republic of Mauritius
- Assessing the Submarine Groundwater Discharge Flux to Meet Potable Water Demand and Improve Domestic Water Supply in Coastal Regions
- Investigation of land sea interactions through groundwater discharge
- Evaluating the Anthropogenic Accumulation of Micro-Plastics across Mauritian Waters
- Tsunami Preparedness Map
- Bioprospecting of Mauritius Waters (Biological activities of marine natural substances from Mauritius Waters)
- Mapping of oceanic and coastal environments of the Republic of Mauritius; Component- Characterizing and mapping of coastal and oceanic environments
- Development of an inundation map in case of Tsunami based on updated data
- Mapping of oceanic and coastal environments of the Republic of Mauritius; Component - Development of an ocean database
- Satellite remote sensing: Operational service and ocean indicators and Regional Ocean Modelling System (ROMS) /Long term variation of sea surface temperature and chlorophyll-a concentration in the Indian Ocean using remote sensing
- Database of Marine Organisms of Mauritius - http://moi.govmu.org/marinedb/

Key Institutions mandated with monitoring and implementation

- Ministry of Agro-Industry and Food Security
- Reef Conservation
- Eco-Sud
- Marine Oceanography Institute - monitoring for Environment and Security in Africa
- Marine Conservation Division, which operates under the Albion Fisheries Research Centre, Ministry of Blue Economy, Marine Resources, Fisheries and Shipping

3.5 Mozambique

The MEDA identified a number of areas of concern including coastal pollution (sewage and

[16] http://moi.govmu.org/research/ongoing-projects Accessed on 14/11/2020

domestic solid wastes, untreated industrial waste, agricultural runoff), overfishing, coastal erosion, habitat loss (mangroves), coral bleaching, destructive fishing methods (dynamite, poison) (Mozambique MEDA Annex IV. Areas of concern).

The VNR on the implementation of the sustainable development goals indicates that some of the actions implemented by the Mozambican government to achieve SDG 14 include the introduction and extension of temporal closures for the artisanal fishing trawl in Sofala Bank and Maputo Bay; the development of fisheries management plans and the Sea Policy and Strategy, co-management, and signing the Agreement on Port State Measures to Prevent, Discourage and Eliminate Illegal, Unreported and Unregulated Fishing (enforced in 2016)[17]. The VNR also shows that Mozambique has made some progress in achieving SDG 3 (quality health), SDG 11 (sustainable cities and communities) and SDG 13 (climate action) but progress is limited for all other SDGs[17].

Mozambique currently reports data for one of the 10 SDG 14 indicators, specifically indicator 14.5.1 Coverage of protected areas in relation to marine areas. The Ministry for Sea, Inland Waters and Fisheries is responsible for providing the data for this indicator (Mozambique VNR, 2020, pg. 118). The VNR recognizes the following challenges to the implementation of SDG 14 in Mozambique:

- Coastal exploitation, habitat destruction and destructive fishing;
- Limited capacity to manage marine and coastal ecosystems and to conduct monitoring, control and surveillance of marine resources;
- Limited legal framework;
- Mozambique is one of the African countries most exposed to climate-related risks. This will negatively impact fishing conditions and the living conditions of coastal communities.

Monitoring Programmes

The Fisheries Research Institute in Mozambique (IIP) oversees sanitary certification and licensing, and the fish inspection laboratories[18]. The fish inspection laboratories conduct sensory, chemical and microbiological analysis. IIP has five laboratories located in Maputo, Beira, Quelimane, Nacala and Angoche. According to the Mozambique MEDA, the following marine coastal monitoring programs were run by IIP (Source: Mozambique MEDA Annex XIV Inshore Oceanographic Monitoring plan):

- Maputo Bay monitoring program
- Sofala Bank monitoring of oceanographic condition
- Pemba Bay monitoring
- Nearshore monitoring of environmental conditions in the small-scale fishing and landing areas
- Environmental study of the Bilene Lagoon

[17] https://sustainabledevelopment.un.org/content/documents/26314VNR_2020_Mozambique_Report.pdf Accessed on 14/11/2020

[18] http://www.inip.gov.mz/index.php/en/areas-tecnicas/analises-laboratoriais Accessed on 14/11/2020

Other ongoing relevant projects include:

- Governance and Shared Growth of Fisheries - SWIOFish1 MZ[19]
- Strengthening the resilience of vulnerable communities in the coastal zone in Mozambique[18]
- Artisanal fisheries for adaptation to climate change (PPAMC / FishCC) [18]
- Promotion of artisanal fisheries – Propesca [18]
- Project to reinforce access rights to resources by artisanal fishers - ProDIRPA[18]
- Coral reef monitoring, sporadic monitoring collecting information on hard coral and fleshy algal cover. Fish data has been collected in 2003, 2005, 2011, 2014 and 2015, and mostly not at the same sites (Obura et al., 2017).
- The Billfish Interactions, Livelihoods, and Linkages for Fisheries sustainability in the Western Indian Ocean (BILLFISH – WIO) project (2019-2022).
- The Enabling Sustainable Exploitation of the Coastal Tuna Species (Kawakawa and Skipjack) in the Western Indian Ocean (2018-2021) project
- The Slippery resource in peril: Ecology of Western Indian Ocean Anguillid eels and their contribution to sustainable fisheries and livelihood along the East Coast of Africa (2019-2022) project.
- The WIO-BENTH project 'Identification, characterization and vulnerability assessment of benthic ecosystems in the WIO" .

Key Institutions mandated with monitoring and implementation

- Ministério do Mar, Águas Interiores e Pescas (MIMAIP)
- Ministério da Terra, Ambiente e Desenvolvimento Rural (MITADER)
- Administração Nacional das Pescas (ADNAP)
- Instituto Nacional de Hidrografia e Navegação (INAHINA)
- Instituto de Investigações Aquáticas (IIA)

3.6 Seychelles

The MEDA identified a number of areas of concern including coastal erosion, coral bleaching, urban expansion, overfishing, conflict between fisheries and tourism, and invasivr species (Seychelles MEDA Annex IV. Areas of Concern).

The VNR on the implementation of the sustainable development goals indicates that Seychelles has made significant efforts to achieve the implementation of the SDGs. Some of the initiatives developed by Seychelles to achieve SDG 14 include[20]:

- Development of two fisheries co-management plans for artisanal and semi-industrial fisheries.
- Development of the Fisheries Comprehensive Plan, launched in November 2019 by the Ministry of Fisheries and Agriculture, to guide future actions and the development of the fisheries sector for the next three years.

[19] http://www.mimaip.gov.mz/projectos/ Accessed on 14/11/2020

[20] http://www.finance.gov.sc/uploads/files/Voluntary%20National%20Review%202020%20-Seychelles.pdf Accessed on 10/11/2020

- The Marine Spatial Planning (MSP) Initiative was launched to meet Seychelles commitment to protect 30% of their Economic Exclusive Zone. SDG target 14.5 (to conserve at least 10 per cent of coastal and marine areas) has been exceeded by Seychelles.
- Development of the Coastal Management Plan (CMP) 2019-2024 and current revision of the Environmental Impact Assessment regulation to make it more effective.
- Creation of the Seychelles Conversation and Climate Adaptation Trust (SeyCCAT) as a result of Seychelles' Debt for Nature Swap
- Launch of the world's first sovereign blue bond in October 2018 to support sustainable marine and fisheries projects through private investment.
- The Ministry of Environment, Energy and Climate Change (MEECC) banned the import and use of plastic bags, straws, single use cutlery and Styrofoam.
- Four more legal acts were approved to support the commitment to the International Convention for the Prevention of Pollution from Ships (MARPOL) in December 2019.
- Ocean literacy campaigns and scholarship programmes
- Approval of the Defence (Amendment) Act in 2020 to 'provide a legislative framework to govern the activities of the Seychelles Coast Guard'. The powers of the Seychelles Coast Guard have been strengthened to 'intercept, search and detain vessels suspected of engaging in illegal activities, including illegal, unreported and unregulated fishing'.

Seychelles currently reports data for two of the 10 SDG 14 indicators, specifically indicators 14.4.1 Proportion of fish stocks within biologically sustainable levels and 14.5.1 Coverage of protected areas in relation to marine areas. The National Bureau of Statistics is in charge of the data processing for SDG reporting in Seychelles[19].

The VNR states that the next steps to achieve the implementation of the SDGs in Seychelles are:

- Identify new and innovative financing mechanisms to ensure successful implementation, monitoring and reporting of the goals;
- Strengthen the inter-governmental coordination mechanism to enable better synergy and coherence for policy planning across government;
- Conduct more robust data collection, processing and dissemination efforts to enable Seychelles to better report on such commitments.

Monitoring Programmes

The Seychelles MEDA lists a number of projects related to the marine and coastal environment taking place up to 2012, selected projects directly relevant to the fisheries sector are (Source: Seychelles MEDA Annex VI. National Projects recently undertaken or currently underway):

- Aldabra Marine Programme phase VII
- Impacts of coral bleaching on coral reef structure and fish assemblages and active management scenarios to aid recovery.
- Baseline survey of alien invasive species on coral reef communities in the Seychelles outer islands.
- Study of light pollution in Seychelles.
- Coral reef dynamics in Cousin Island marine reserve.
- Fishes of Aldabra Island.
- An evaluation of the ecosystems services, their associated benefactors and management implications for the coral reef fisheries of Seychelles.

- Inter-annual and seasonal variation in feeding and breeding ecology of tropical Roseate Terns and Lesser Noddies on Aride Island.
- Global phylogeography of Sphyraena Barracuda
- Study of reef resilience in Aldabra and D'Arros Island
- Impact of forcing of natural and human origin on the diversity of coral reef fishes in the Seychelles archipelago
- Tolerance, refuge and recovery of coral reef communities to thermal bleaching: evidence from reefs of the Seychelles.
- Food security and climate change in Small Island Developing States (SIDS): A case study of the republic of the Seychelles.
- Identification of humpback whales in Seychelles waters
- Genetic monitoring of whale sharks.
- Constraining Mid-late Holocene Eustatic Sea level change in the Seychelles

The Seychelles Fishing Authority (SFA) is involved in the following monitoring programmes (Source: Seychelles MEDA Inshore Oceanographic Monitoring Programme):

- Seychelles Ocean Temperature Network
- Reef Monitoring and Coral Bleaching Monitoring: Seychelles National Parks Authority is the main organisation responsible for coral reef monitoring
- The Third South West Indian Ocean Fisheries Governance and Shared Growth Project (SWIOFish3) in Seychelles
- Water and sediment quality monitoring
- Oceanographic monitoring
- NOAA coral Bleaching Monitoring, carried out via remote sensing

Other monitoring programmes implemented by Nature Seychelles include:

- The hawksbill turtle (*Erechmotelys imbricata*) monitoring and research. In Cousin Island, turtle monitoring has been conducted since 1972 and tagging since 1973. Nesting beaches are patrolled several times a day during daylight[21].
- The 'Reef Rescuers' project started in 2010, with the aim to restore the fringing coral reef within Cousin Island Special Reserve.
- Impacts of climate change on populations of Hawksbill turtles in Seychelles.
- The 'Enhancing coastal and marine socio-ecological resilience and biodiversity conservation in the Western Indian Ocean' project funded by The German International Climate Change Initiative through the German Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. The focus areas are Mozambique and Seychelles with collaboration from Kenya and Tanzania[22].

Key Institutions mandated with monitoring and implementation

- Ministry of Environment, Energy and Climate Change

[21] http://www.natureseychelles.org/what-we-do/wildlife-conservation/marine-turtle-programme Accessed on 28/11/2020

[22] http://www.natureseychelles.org/what-we-do/leap-project Accessed on 29/11/2020

- Seychelles National Park authority
- Seychelles Fishing authority
- Seychelles Marine Spatial Plan Initiative https://seymsp.com/resources/legislation-policy/
- Nature Seychelles
- The Ocean Project – Seychelles
- WiseOceans - Seychelles

3.7 Somalia

The MEDA identified a number of areas of concern including coastal erosion, pollution, coral and sand mining, urban expansion, habitat destruction, destructing fishing practices, overfishing, (Somalia MEDA Annex IV. Areas of concern). IUU by foreign fishing vessels is a major issue affecting Somalia (Glaser et al., 2019 and references therein). These authors reported that foreign fishing increased more than 20 times in Somalia since 1981, and caught 92500mt of fish in 2014. Glaser et al. (2019) concluded that foreign IUU fishing is contributing to the ongoing conflict in Somalia by 'directly competing with the domestic fishery; through links to piracy; through nearshore illegal and destructive bottom trawling; by contributing to regional political conflict over vessel licensing; and by reducing long-term livelihood security'.

Somalia has not submitted a voluntary national review for the implementation of the SDGs.

Monitoring programmes

Fisheries statistics were reported by Somalia to the FAO from 1985, however, no data collection took place for over 20 years as well as no fish stock assessment[23].

- Improving the catch data collection system for Somali fisheries: Project Kalluun (Sheikheile et al., 2018)[24]. A collaboration between the Ministry of Fisheries and Marine Resources, City University, Secure Fisheries, and FAO aiming to improve the collection of fisheries data in Somalia. The project started in 2017 with data collection in two landing sites in Mogadishu and was expected to extend to four landing sites in 2020. Details on the fisheries data collection system in Somalia and the outcomes of project Kalluun can be found in Sheikheile et al., (2018).

- First National Hydro-Meteorological and Monitoring Service in Somalia[25] is funded by the Global Environmental Facility and United Nations Development Programme. The project will be implemented by the Ministry of Energy and Water Resources, and aims to 'alleviate the impacts of climate-induced shocks such as floods, cyclones and drought' that have displaced 2.6 million people in Somalia.

The Somalia MEDA lists the following projects related to the marine and coastal environment

[23] https://www.crc.uri.edu/download/SOM14_polpaper.pdf Accessed on 29/11/2020

[24] https://www.iotc.org/documents/WPDCS/14/38-SOM Accessed on 29/11/2020

[25] https://sdg.iisd.org/news/gef-undp-project-advances-sdgs-in-somalia-through-hydromet-services/ Accessed on 29/11/2020

taking place up to 2012 (Source: Somalia MEDA Annex VII. National Projects recently undertaken or currently underway):

- Somali Marine and Coastal Monitor;
- Integrated Livelihoods Program;
- Tsunami Emergency and Recovery Program;
- Somali water, land and Information management-Phase III;
- Food security and nutrition analysis;
- Strategic partnership for a sustainable fisheries investment fund in the Large Marine
- Ecosystems of sub-Saharan Africa-MSP;
- Rapid resource rehabilitation of rural livelihoods;
- Support the food security analysis understanding livelihoods;
- Improved small-scale landing, handling and storage infrastructure;
- Implementation of three quality inspection and certification laboratories (fish and fishery products).

Key Institutions mandated with monitoring and implementation

- Ministry of Fisheries and Marine Resources
- Ministry of Energy and Water resources
- Somali Marine and Fisheries Research Institute
- City University of Mogadishu – Marine and Fisheries Institute

3.8 South Africa

The MEDA identified a number of areas of concern including estuary degradation, land-based pollution, mining (sand, titanium, diamonds, fossil fuels and phosphate) ocean warming, changes in upwelling trends, distribution changes of important commercial species among others (National Biodiversity Assessment: Skowno et al., 2018).

The VNR on the implementation of the sustainable development goals indicates that the initiatives developed by South Africa to achieve SDG 14 include strengthening monitoring and reporting systems for improved environmental performance, developing policies to support environmental protection and the Blue Economy, Operation Phakisa, the development of a harmful algal blooms decision-support system and ZACUBE-2 Mission, which developed an automatic identification system to monitor illegal fishing in South African oceans[26].

South Africa currently reports data for two of the 10 SDG 14 indicators, specifically indicators 14.5.1 Coverage of protected areas in relation to marine areas and 14.7.1 Sustainable Fisheries as a Percentage of GDP (StatsSA, 2017, FAO, 2020).

Monitoring Programmes

The National Aquatic Ecosystem Health Monitoring Programme (NAEHMP) has 10 water-resource-quality monitoring programmes, with a main focus on riverine ecosystems). The programmes relevant to this analysis are:

[26] https://sustainabledevelopment.un.org/content/documents/23402RSA_Voluntary_National_Review_Report__9_July_2019.pdf

- National estuarine monitoring programme for South African estuaries (NEsMP)

NEsMP was designed by reviewing international best practices and existing national monitoring programmes implemented by the DWS together with expert opinion. NEsMP' objectives are 'to measure, assess and report on a regular basis on the status and trends of the nature and extent of the condition of South African estuaries in a manner that will support strategic management decisions to ensure sustainable use of estuaries and ensure ecosystem integrity, being mindful of financial and capacity constraints, while also being be scientifically sound'.

The programme was designed in three tiers:

Tier 1 focused on data collection using the methods for estuarine flow. Top 30 priority estuaries were determined using the methods of Cilliers and Adams, (2016) based on a number of criteria including the availability of financial and human resources. Monitoring started on 21 priority estuaries between 2012 and 2014 in collaboration with government conservation authorities, conservation forums and local and district municipalities.
Tier 2 focuses on specific aspects of the Resource Directed measures to determine estuarine freshwater inflow requirements
Tier 3 focused on short-term tailored monitoring to address specific management issues (e.g. pollution or other threats affecting the integrity of the system).

The outcomes of the NEsMP include the monitoring programme, an integrated database, integrated estuarine management, estuarine Health comparison and Indices development (Cilliers and Adams, 2016). Data and information product can be accessed through the South African Estuary Information System (SAEIS) – SAEON Elwandle node.

Other monitoring programmes include:

- Mooring arrays (SAEON and the University of Cape Town)

There are several large mooring arrays deployed within South Africa Economic Exclusive zone as part of the South Atlantic Meridional Overturning Circulation project. The South African component (SAMOC-SA) has three mooring arrays:

1) South Atlantic Meridional Basin-Wide Array (SAMBA) – shelf and tall moorings with ADCPs (Acoustic Doppler Current Profile), current meters, MicroCAT CTDs (Conductivity-Temperature-Depth, including dissolved oxygen sensors), and current and Pressure-Inverted Echo Sounders (CPIES) (Atkinson et al., 2016). A CTD transect is sampled annually, zooplankton and biogeochemical sampling was scheduled to start in September 2016 (Atkinson et al., 2016)
2) Good Hope, annual monitoring is conducted in this transect since 2014 including deep CTD casts, EXpendable BathyThermograph (XBT) casts, lagragian instrument deployments (e.g. Argo floats and Surface Velocity Program (SVP) drifters) and CPIES moorings have been deployed along the first section of the line (since 2016) (Atkinson et al., 2016).
3) CrossRoads, annual monitoring is conducted in this transect during the return voyage from Marion Island and includes high resolution CTD and XBT line monitoring long-term trends of the Agulhas Return Current and the Agulhas Current itself (Atkinson et al., 2016).

The South African Coastal Temperature Network established in 2014, consists of HOBO and Star-Oddi temperature loggers placed within 5 m water depth at 127 sites (in 2016) around

South Africa (Atkinson et al., 2016).

- Waste-water outfall monitoring (CSIR)

The following monitoring programmes are coordinated by the Coastal Systems Research Group based in Durban:

Table 3. List of sediment and water quality monitoring programs coordinated by the CSIR. Adapted from Atkinson et al., 2016

Location	**Monitoring frequency**	**Parameters monitored**
Durban	Annual (since the late 1970s)	Sediment and water quality, including toxicity testing, macrofauna
Richards Bay	Annual (since the early 1980s)	Sediment and water quality, including toxicity testing, macrofauna, meiofauna, benthic fish and mega-invertebrates
Sappi SAICCOR (off the Umkomaas estuary)	Annual (since the early 1980s)	Sediment and water quality, including toxicity testing, macrofauna
Hout Bay	Annual	Sediment and water quality, including toxicity testing
Camps Bay	Annual	Sediment and water quality, including toxicity testing
Greenpoint	Annual	Sediment and water quality, including toxicity testing
Vleesbaai	Every 3 years	Sediment and water quality, macrofauna, meiofauna
Chevron (Table Bay)	Every 3 years	Sediment and water quality
Sizela (± 70 km south of Durban)	Annual	Sediment interstitial water quality and meiofauna
Durban		Mussel toxicity watch
Harbour monitoring (Richards Bay, Durban, East London, Ngqura, Port Elizabeth, Mossel Bay and Cape Town)	Annual (since 2009)	Water quality measured twice annually, sediment chemistry, macrofauna and metal and hydrocarbons in mussels are measured annually

The Department of Environment, Forestry and Fisheries (DEFF, previously Department of Agriculture, Forestry and Fisheries-Fisheries management) has the following fishery-independent monitoring programmes (Hutchings et al., 2010):

- Hydroacoustic survey programme to estimate pelagic fish biomass (conducted by former DAFF)

Acoustic estimates of anchovy spawner biomass are made every November since 1984, recruitment biomass is estimated annually since 1985 during winter. Estimates of round herring, juvenile horse mackerel and mesopelagic fish biomass are also obtained during these surveys, however, the time series do not date back to 1984 and are available from 2006 onwards for mesopelagic fish.
Environmental information is also collected during these surveys and include temperature, salinities, oxygen and turbidity. Information on the abundance and distribution of ichthyoplankton of epipelagic and mesopelagic fishes and ichthyoplankton of some other fish species is also collected.

- Swept area demersal trawl surveys (conducted by former DAFF)

These surveys aim to estimate the abundance of demersal fish, elasmobranchs, cephalopods and invertebrates. The surveys are conducted every year since 1984 at the west and south coast of South Africa. The surveys cover approximately 120 sites each year between the coast and 1000 m isobath (Atkinson et al, 2016).

- Fishery Independent Monitoring Survey (FIMS)

Annual relative abundance estimates of west coast rock lobster conducted since 1992, estimates of the size and sex compositions of the population are also available.

- Fisheries Statistics

Landing statistics are collected and managed by the DAFF including commercial and small-scale subsistence fisheries.

- Harmful Algal Blooms

A HAB monitoring and research programme spanning from 1989 to 2015 has the main aim of providing a 'warning and information system to the public and the aquaculture and fishing industry of developing harmful blooms'. The programme included reporting red tides and daily collection of phytoplankton samples from Elands Bay and Gordons Bay (Atkinson et al., 2016). The South African Molluscan Shellfish Monitoring and Control Programme (SAMSMCP), implemented in 2000, aims to 'primarily serve the aquaculture industry by providing the necessary guarantees to foreign buyers and Governments, and to local consumers, that the risk of disease and poisoning through consuming molluscan shellfish is adequately managed and minimised'.

The HAB decision support tool of the National OCIMS uses a combination of ocean colour-derived phytoplankton biomass proxies, sea surface temperature, wind, currents and sea state to provide information on HAB events in the South African coast up to 50 km offshore.

- Integrated monitoring conducted by the former Department of Environmental Affairs (now DEFF)

Integrated Ecosystem Programme: Southern Benguela has four monitoring transects (Scarborough, St. Helena, Namaqua and Kleinsee), which are sampled quarterly each year (Atkinson et al., 2016). The Kleinsee transect (south of Port Nolloth) monitors seasonal upwelling, seals and seabirds, baseline data for the proposed MPA is collected at the Namaqua transect, the St Helena Bay transect monitor water retention and productivity and The Scarborough transect

(south of Cape Town) monitor the Benguela Jet and Agulhas Current intrusion (Atkinson et al, 2016). A number of environmental variables are collected at these transects including oxygen, pH, CO_2.

The South African Monitoring Programme of Marine Plankton (SAMPoMP) is an ongoing programme, and aims to implement monitoring of phytoplankton, zooplankton and harmful algal blooms in the whole South African EZZ (Atkinson et al., 2016). Monitoring is planned to start at the four above-mentioned transects. However, phytoplankton and zooplankton time series are available for St Helena Bay and span six decades, with no information available during the 1970s and early 1980s (Verheye et al., 2016). Zooplankton monitoring off the south coast of South Africa is conducted annually since 1988 during the acoustic surveys of pelagic fish biomass (Huggett et al., 2019).

Six seabird species (African penguin, Cape gannet, Cape cormorant, Bank cormorant, White-breasted cormorant and swift tern) are monitored annually at 17 stations in South Africa. For African penguins, counts are mostly conducted during the main breeding season (Feb-Sep) in South Africa (Hockey et al. 2005). In terms of seal populations, 11 colonies are monitored in South Africa. Information collected includes count of seal pups (every three years), diet information (monthly) at Lamberts Bay, Geyzer Rock and Mossel Bay. Analysis of the information collected by DEA (now DEFF) is made available through the South Africa's Oceans and Coasts Annual Science Report, available from the Department's website.

The long-term intertidal monitoring programme is a result of the collaboration of SANParks, Cape Nature, Eastern Cape Parks and Tourism, Ezemvelo Kwa-Zulu Natal Wildlife and the University of Kwa-Zulu Natal. This programme started in 2015 and aims to detect impacts of climate change, pollution and alien invasions on coastal diversity focused on rocky shores, shallow subtidal reefs and estuaries. Monitoring sites include Namaqua National Park, Elands Bay, Betty's Bay Marine Protected Area (MPA), Goukamma MPA, Robberg MPA, Dwesa-Cwebe MPA and Kwa-Zulu Natal (Atkinson et al., 2016). A standard methodology is used in all monitoring sites, percent cover of all invertebrates and algae are recorded, as well as counts of all invertebrate species (Atkinson et al., 2016).

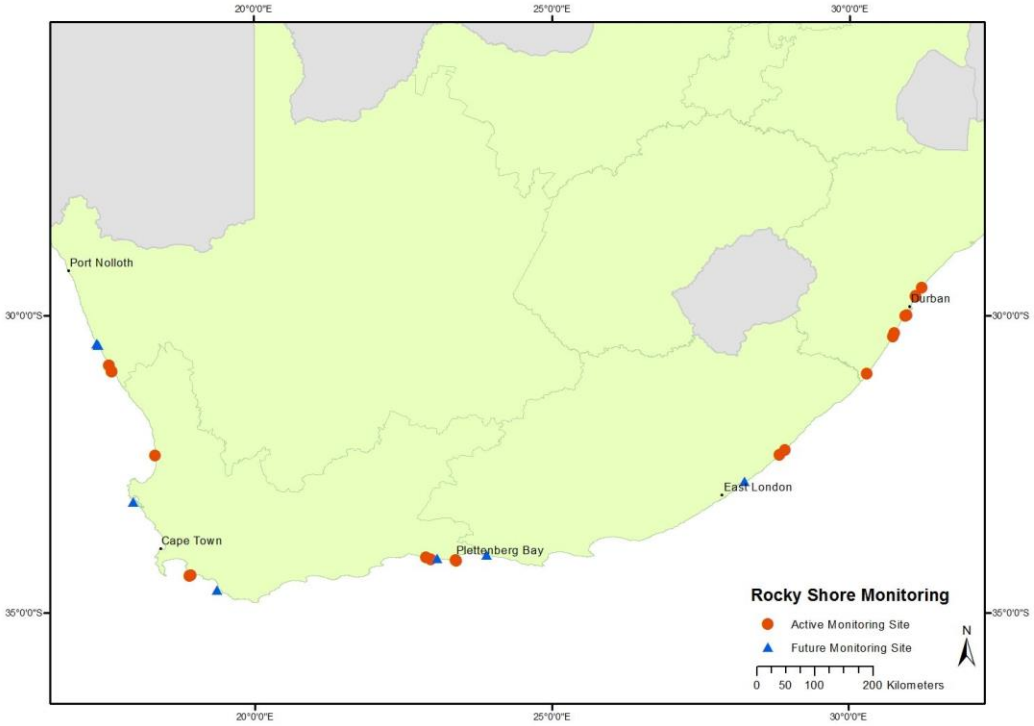

Figure 1. Rocky shore monitoring programmes in South Africa. Source: Atkinson et al., 2016

- Monitoring programmes by SANParks

This programme focuses on the Marine Protected Areas managed by SANParks including Table Mountain National Park, West Coast National Park, Agulhas National Park, Langebaan Lagoon and Goukamma MPAs. Monitoring focuses on linefish, the impact of prawn harvesting and trampling, intertidal communities. Detailed information on these monitoring programmes can be found in Atkinson et al., 2016.

- Sentinel sites (SAEON)

The shallow marine and coastal infrastructure (SMCRI), launched by the Department of Science and Technology, the National Research Foundation and Nelson Mandela University, is managed by the South African Environmental and Observational Network (SAEON) Elwandle Node. The SMCRI has the following 13 platforms: Algoa Bay Sentinel Site, Natal Bight Sentinel Site, Marion Island Sentinel Site, Two Oceans Sentinel Site, Satellite Sentinel Sites, Airborne Remote Sensing Platform, Coastal Biogeochemistry Platform, Hyperbaric Chamber Platform, Data Management Platform, Science Engagement Platform, Coastal Craft Platform, Acoustic Telemetry Array Platform and Marine Remote Imagery Platform[27]. The Coastal Biogeochemistry, Hyperbaric Chamber and Data Management Platforms are housed in the Port Elizabeth Central Coordinating Unit, while the Acoustic Telemetry Array, Marine Remote Imagery, the Coastal Temperature Network and aerial surveillance platforms operate along the entire coastline.

The Algoa Bay Sentinel is located in the south-east coast of South Africa and extends from Port Alfred to Oyster Bay. The Algoa Bay sentinel site is one of the best monitored areas in Africa. The continuous monitoring platform (CMP), constitutes the physical part of the monitoring

[27] https://www.nrf.ac.za/sites/default/files/documents/09%20NRF%20SMM%20V1%20Issue2%20SAEON%20%26%20SAIAB.pdf Accessed on 18/09/2020

programme, monitors temperature structures (coastal and nearshore) and current profiles and variation in other water column properties using Acoustic Doppler Current Profilers (ADCP), Underwater Temperature Recorders (UTR), Gully Temperature Probes (GTP) and Moored Sea-Bird CTD deployments in 40 permanently moored in situ observatories[28]. The sentinel site also has weather, wave, sea level stations, monitored in partnership with institutions like the South African Weather Service and the Council for Scientific and Industrial Research. The Acoustic Telemetry Array Platform (ATAP) has a number of stations and transects in the Bay with acoustic receivers (Fig. 2)

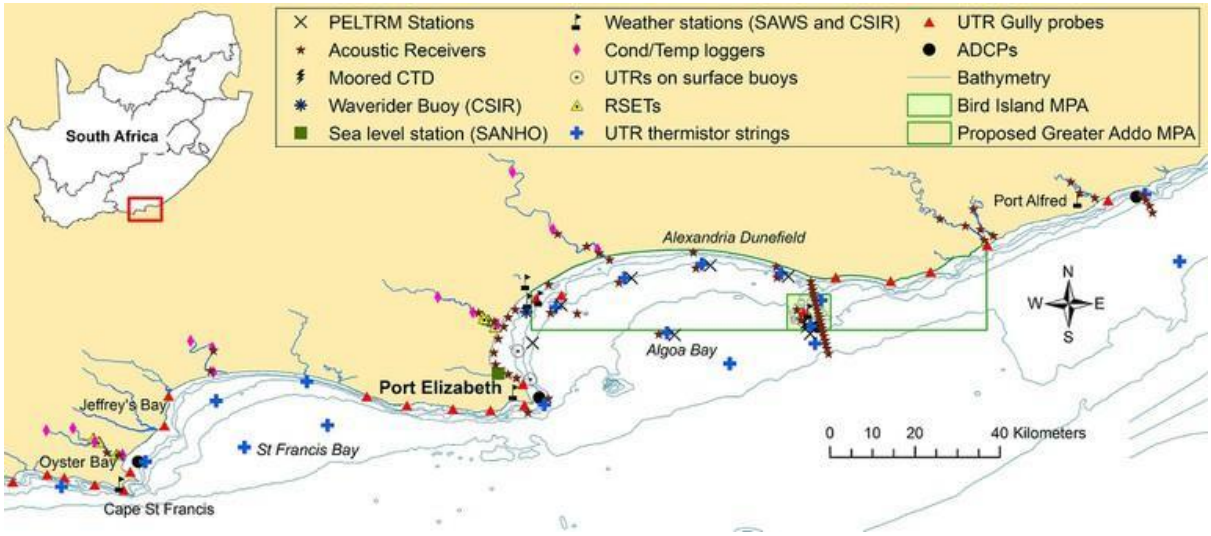

Figure 2. Map of the Algoa Bay sentinel site. Source: Dr Tommy Bornman, SAEON Elwandle Node

The Pelagic Ecosystem Long-term Ecological Research Programme aims to 'provide a holistic understanding of the temporal and spatial dynamics of the lower-trophic pelagic ecosystem of Algoa Bay'. The PELTER programme started in May 2010 as a collaboration between SAEON and NMU. Nutrient dynamics, physical and chemical drivers of phytoplankton and zooplankton, phytoplankton and zooplankton diversity and dynamics are sampled monthly at eight stations throughout Algoa Bay.

The rocky shore and subtidal reefs of the Jaheel, St Croix and Bird Island complexes of Algoa Bay are monitored (community composition) along transects. Baseline monitoring was conducted in 2000 and every 2 years subsequently, since 2012, seasonal sampling is conducted (Atkinson et al., 2016). Sandy beaches and groundwater monitoring is also conducted in Algoa Bay at 10 surf-zone stations, physical (surf energy, surf-zone width, wave height and surf-zone topography, water temperature), water chemistry (ammonium, nitrate/nitrite, phosphorus and silicate) and biotic (phytoplankton biomass and species composition) variables are monitored monthly since 2010 (Atkinson et al., 2016).

The national Estuaries Network Long-Term Ecological Research is another key programme of SAEON Elwandle monitoring four estuaries in the Eastern Cape:

[28] http://skp.dirisa.org/repository/Elwandle/projects/algoa-bay-sentinel-site/algoa-bay-sentinel-site-continuous-monitoring-platform-cmp Accessed 18/09/2020

- Kromme Estuary: The monitoring programme started in May 2012, and the CMP has stations in the lower, middle and upper reaches of the estuary. Physico-chemical variables and the pelagic ecosystem are sampled monthly at six stations along the estuary. Physico-chemical profiling is also conducted at 24 stations along the estuary to determine spatio-temporal variability. If episodic events such as flood, plankton blooms take place, the estuary is also monitored in additional occasions to report the conditions (See Tier 3 of NEsMP) [29].

- Gamtoos Estuary: Started in June 2013, the lower, middle and upper reaches of the estuary are monitored as part of the CMP. Quarterly sampling of physico-chemical and pelagic ecosystem variables at 10 fixed stations along the estuary. Physico-chemical profiling is conducted at 20 stations along the estuary. Episodic events are monitored as for the Kromme Estuary.

- Swartkops Estuary, monitoring of temperature, salinity and sediment accretion take place in this estuary.

- Kariega Estuary: Started in November 2012, the lower, middle and upper reaches of the estuary are monitored at three stations as part of the CMP. Quarterly sampling of physico-chemical and pelagic ecosystem variables takes places at five fixed stations along the estuary. Physico-chemical profiling is conducted on a quarterly basis at 84 fixed stations along the estuary. Episodic events are monitored as for the Kromme Estuary.

The Marine Protected Area network conducts applied and basic ecological research on subtidal reef habitats in South Africa. The monitoring programme includes[30]:

- Agulhas Ecoregion Reef Fish Monitoring Survey, this initiative started in 2013 aiming to assess reef fish populations, macro-benthic communities and habitats nationally using stereo Baited Remote Underwater Videos (stereo-BRUVs). The monitoring is conducted on board of the R/V Ellen Khuzwayo in partnership with DEFF.

- Tsitsikamma National Park Long-term Ecological Research and Monitoring Programme started in 2006, aiming to 1) compare different monitoring methods and 2) conduct long-term monitoring of fish communities within the Tsitsikamma MPA. The programme is conducted in partnerships with South African National Parks.

- Algoa Bay Stereo-BRUV Fish Survey of Shallow and Deep Rocky Habitats started in 2013, investigates 'habitat-fish relationships with particular focus on depth and zonation in Algoa Bay using stereo-BRUVs'. This programme is conducted in partnership with the South African Institute for Aquatic Biodiversity.

- The Agulhas System Climate Array (ASCA), coordinated by SAEON in collaboration from DEA, is a five-year initiative to monitor the Agulhas Current using an array of moorings (which includes ADCPs, current meters and microCAT CTDs) along with Current and Pressure-Inverted Echo Sounders (CPIES). These moorings were deployed in April 2015 and will be serviced every 12 to 18 months.

[29] http://elwandle.dirisa.org/Science/Project%20Descriptions/estuaries-long-term-ecological-research-programme-e-lterp Accessed 18/09/2020

[30] http://elwandle.dirisa.org/Science/Project%20Descriptions/marine-protected-areas Accessed 19/09/2020

- False Bay Habitat and Fish Inventory Remote Video Survey

- Monitoring programmes by the Oceanographic Research Institute

The following monitoring programs are conducted in the KwaZulu-Natal coastline with a focus on invertebrates and fish species (Atkinson et al., 2016):

1. Long-term monitoring of commercial harvested oysters
2. Long-term mussel monitoring
3. Invertebrate catch statistics by recreational/subsistence fishers
4. ORI cooperative fish tagging project
5. iSimangaliso Surf-zone fish monitoring and tagging project
6. Pondoland MPA Reef-fish monitoring project
7. National Marine Linefish system – KZN recreational data
8. KZN boat launch site monitoring system
9. ORI long-term coral reef monitoring project

- Monitoring programmes by Ezemvelo KZN Wildlife

The following programs are run by EKZNW (Table 4):

1. Rocky shore monitoring programme from Kosi Bay to Port Edward
2. Reef monitoring Programme

Table 4. List of monitoring programs coordinated by the EKZNW. Source: Atkinson et al., 2016

Location	Monitoring frequency	Parameters monitored
KZN coast	Annual	Non-consumptive resource use monitoring including activities such as SCUBA diving, pleasure cruises and whale watching along the KZN coasts
Rocky shore - Kosi Bay to Port Edward (7 stations)	Annual	Invertebrate biodiversity
Reef (6 sites)	Annual	Invertebrate biodiversity, seawater temperature,
Mozambique border to Jesser Point, Sondwana Bay (from 2014)	Annual during the breeding season (Oct-March)	Loggerhead and leatherback female turtles coming ashore to lay eggs are tagged, micro-chipped. Morphometric and nesting data are collected. Conducted in partnership with DEA
KZN coast	As needed	Stranding monitoring, including species, location and status information.

- Monitoring programmes by SANBI

The SeaKeys project of the South African National Biodiversity Initiative aims to 'collate, increase and disseminate marine biodiversity information and support the application of this knowledge in monitoring, decision making and maintaining benefits from marine biodiversity for South Africans'[31]. This project collected information on marine monitoring initiatives in South Africa through stakeholder consultations, workshops and collation of information. The project produced a report with monitoring initiatives available until 2015 in South Africa and a spatial project with the location of all monitoring project in South Africa (Atkinson et al., 2016).

Coral bleaching monitoring is conducted annually at iSimangaliso Wetland Park since 2011 aiming "to assess and provide early warning for extreme environmental conditions that may lead to coral bleaching in South Africa" (Atkinson et al., 2016). Baseline data was collected in 2005, 2007 and 2008. A maximum of 16 sites are monitored, with at least 250 individual coral colonies scored a bleaching index (from McClanahan et al. 2007). Seawater temperature is recorded at 9 sites.

- Coordinated Waterbird Counts[32]

This programme started in 1998 and currently monitors over 400 wetlands around South Africa, and curates waterbird data for over 600 sites. This is a citizen science programme and thus the counts are conducted by volunteers; people and organisations with a passion for waterbird conservation. The program is managed by the University of Cape Town's FitzPatrick Institute of African Ornithology since 2018.

Institutions mandated with monitoring and implementation

- Department of Water and Sanitation (DWS)
- Department of Environment, Forestry and Fisheries (DEFF)
- Provincial and local governments
- Conservation bodies (e.g. SANParks, Ezemvelo/KZN Wildlife, Eastern Cape Parks & Tourism Agency)
- South African Environmental Observation Network (SAEON)
- South African National Biodiversity Institute (SANBI)
- South African Biodiversity Institute (SAIAB)
- Nelson Mandela University
- Water Research Commission (WRC)
- The Council for Scientific and Industrial Research (CSIR)

3.9 Tanzania

The MEDA identified a number of areas of concern including coastal erosion, increasing freshwater abstraction, coral bleaching and mining, extreme events, pollution, destructive fishing methods, overfishing, unsustainable mangrove harvesting, among others (Tanzania MEDA Annex IV. Areas of Concern).

The VNR on the implementation of the SDGs[33] and the performance audit on preparedness for

[31] http://bgis.sanbi.org/Projects/Detail/182 Accessed on 20/09/2020
[32] http://cwac.birdmap.africa Accessed on 27/09/2020
[33] https://www.nbs.go.tz/nbs/takwimu/SDGs/VNR_Report_Tanzania_2019.pdf Accessed on 30/11/2020

implementation of SDGs prepared by the Minister of Finance and Planning state that the Tanzanian Government has focused on seven SDGs on the areas of governance, environment, infrastructure and energy for implementation. SDG 14 is not one of the priority areas. Moreover, data is currently only available for four of the seven focus SDGs and not for all the indicators within the priority SDGs. The VNR report progress for two of the 10 SDG indicators, specifically 14.b.1 Progress by countries in the degree of application of a legal/regulatory/policy/ institutional framework which recognizes and protects access rights for small-scale fisheries and 14.c.1 Number of countries making progress in ratifying, accepting and implementing through legal, policy and institutional frameworks, ocean-related instruments that implement international law, as reflected in the United Nations Convention on the Law of the Sea.

Monitoring Programmes

The Tanzania MEDA lists a number of projects related to the marine and coastal environment taking place up to 2012, projects directly relevant to the fisheries sector are (Source: Tanzania Annex VII. National Projects recently undertaken or currently underway):

- Coral Reef Targeted Research & Capacity Building for Management (CRTR)
- Marine and Coastal Environment Management Project (MACEMP)
- The Tanzania Coastal Management Partnership (TCMP)
- Transboundary networks of marine protected areas (TRANSMAP)
- Genetic connectivity and Coral reef fish Relevance its implications for the design and management of marine protected areas in the East African Ecoregion (WIOMagnet
- project)
- Shoreline Changes in Tanzania and Kenya, Their Socio-economic Impacts and Mitigation Options
- Sustainable Environmental Management through Mariculture Activities (SEMMA)
- Peri-Urban Mangrove Forests as Filters and Potential Phytoremediators of Domestic Sewage in East Africa (PUMPSEA)
- Rufiji Environment Management Project (REMP/MUMARU)
- Kinondoni Integrated Coastal Area Management Programme (KICAMP)

Detailed information on these projects can be found in the Annex VII of the Tanzania MEDA. Other ongoing projects conducted in partnership with other WIO countries can be found under section 3.2 Kenya.

- *Fisheries statistics – mainland Tanzania*

Monitoring of fishery resources started in the 1960s in mainland Tanzania to provide advice on the management of resources (Sobo and Mgaya, 2005). In terms of the artisanal fishery, frame and catch assessment surveys are used to monitor fishing effort and catch landings respectively (Hamidu, 2012). The fisheries frame surveys were initially conducted every year (1967-1991) but since 1992, the surveys have been conducted bi-annually due to financial constraints (Hamidu, 2012). During 1997-2001, there were issues with the collection of fisheries data as a result of a lack of coordination from the decentralization from central to local government in Tanzania. The monitoring of fisheries statistics is conducted since 2006 in partnership with fishing communities (Beach Management Units), who handled the collection on their landing sites (Sobo, 2012). Since 2008, the catch assessment survey is linked to an online database and

it has become electronic resulting in a major improvement in quality and quantity of the data collected (Rushingisha and Tuda 2019). Fisheries statistics are stored at the Catch assessment survey database managed by the Fisheries Department.

- *Fisheries statistics - Zanzibar*

This program is conducted by the Department of Fisheries and Marine Resources, monthly surveys are conducted at 31 landing sites recording (in hard copies) the landings of 19 taxa including mackerels, tuna-like fishes, sharks and rays, molluscs, lobsters, demersal and pelagic fish (Rehren et al., 2020).

- *Coral monitoring programme*

Monitoring started in the early 1990s in Zanzibar and Mafia, aiming to 'document reef status and in places assess the extent of damage caused by the use of destructive resource harvesting practices, mainly fishing using dynamite and dragged nets' (Muhando, 2009).

In 1994, a SCUBA Based Coral Reef Monitoring (SB-CRM) team was formed as a partnership between the Institute of Marine Sciences, CIDA-Canada and Sida-SAREC (Sweden). Monitoring started off Zanzibar town reefs, in Menai Bay and Mnemba (Unguja) and in Misali (Pemba) (Muhando, 2009). Due to the high cost of the SB-CRM, a community-based coral reef monitoring (CB-CRM) using snorkel, mask and fins was initiated in 1996 by the Tanga Coastal Zone Conservation and Development Program training fisheries officers and local fishers to conduct the monitoring (Horrill et al., 2001). Since the 1998 coral bleaching event, coral reef monitoring sites using SB-CRM were established in 12 sites in Dar es Salaam, Mafia and Mtwara (five in Unguja, one in Pemba, two in Dar es Salaam, two in Mafia and two in Mtwara), and 10 sites using CB-CRM Tanga, Bagamoyo and two in Dar es Salaam) (Muhando, 2009). The categories monitored by both programmes are live hard corals, soft corals, sponges, algae, substrate type and others, no environmental variables are recorded during the monitoring (Muhando, 2009).

- *Tanzania Marine program – World Conservation Society*

The aim of the programme is 'to contribute to the conservation of shark and ray species in Tanzania by collecting comprehensive ecological and fishery data to contribute to the development of management recommendations and shark and ray conservation policy[34]'. The programme focused on monitoring of elasmobranch catches

Elasmobranch catch monitoring started in 2017 and covers important landing sites and fish markets in the mainland, Zanzibar and Pemba Island. Biological data, genetic samples and market data are collected. This monitoring programme is being conducted in partnership with the Tanzania Fisheries Research Institute.

Baited Remote Underwater Video (BRUV) monitoring has been conducted in the mainland coast and Zanzibar to obtain biological data.

The information collected through the project is being used to develop Tanzania's first shark and ray management plan. A coral reef research and conservation program started in 2018.

[34] https://tanzania.wcs.org/Landscapes/Marine-Program.aspx (Accessed September 5th, 2020)

- *Monitoring in Utende, Mafia Island, Tanzania* (TZM 163 Science Report, July-September 2016, White and Anderson)

This programme is conducted as a partnership between the Marine Parks and Reserves Unit and the Frontier Institute (through their Marine Conservation volunteer programme), the monitoring is conducted in Chole Bay and is a five-year research programme (White and Anderson, undated). The programme aims to collect baseline biodiversity data on coral reefs, mangroves and seagrass habitats, compare biodiversity in different use zones, collect socio-economic data on fisheries and other resource extraction activities, and communities (White and Anderson, undated). The information will be used to develop a management plan and risk assessment report for the Mafia Island Marine Park.

Institutions mandated with monitoring and implementation

- Ministry of Livestock and Fisheries
- World Conservation Society
- Zanzibar State University
- Frontier
- Marine Parks and Reserves Unit
- Tanzania Fisheries Research Institute (TAFIRI)
- Institute of Marine Sciences, University of Dar es Salaam
- Fisheries department, mainland Tanzania
- Department of Fisheries and Marine Resources, Zanzibar
- MeerWissen, African-German Partners for Ocean Knowledge
- ZMT Leibnitz-Zentrum fur Marine Tropical Ecology
- Tanga Coastal Zone Conservation and Development Program
- Kinondoni Coastal Area Management Project
- Tanzania Coastal Management partnership

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Appendix 1. Cover letter to stakeholders consultation and ecosystem monitoring programmes

Cover letter to stakeholders

Dear stakeholder,

The effective management of Large Marine Ecosystems depends on an understanding of the state, and the negative or positive impact of policy and management interventions over time which may be evaluated through analysis of long-term ecosystem monitoring programmes. The Development of a Regional Ecosystem Monitoring Framework for the WIOLME project aim to provide a regional framework to monitor the WIOLME across all areas, including inshore and offshore such as critical habitats, coasts and shorelines, and Areas Beyond National Jurisdiction (ABNJ). This assessment will be used to facilitate the monitoring, tracking and recording of biophysical parameters, and will propose harmonized national monitoring activities that contribute to regional ecosystem monitoring efforts.

A consultancy has been appointed to conduct this study on behalf of the SAPPHIRE and WIOSAP projects, and WIOMSA. It is essential for the success of this project to benefit from your knowledge and experience, in sourcing the needed information.

We are reviewing the existing ecosystem monitoring practices, initiatives and programmes in the countries of the WIO region, as well as identifying potential Ecosystem Monitoring Indicators and sites. Since the capacity and approach to ecosystem monitoring activities differ within the countries of the WIO region, it is important to assess the needs of every participating country in the region, including respective capacities and strengths, national monitoring programmes and the feasibility of conducting these programmes. This letter is to invite you to participate on our stakeholder survey that will help us with this project. The survey consists of a questionnaire containing five open questions in which you may also be able to provide suggestions/comments that are relevant to the Development of Regional Ecosystem Monitoring Framework for the WIOLME region.

The answers to this questionnaire are to be submitted no later than 31 August 2020 by email.

If you have any questions or would like further information on this project, please contact me in through the channel provided below.

Thank you for your assistance and attention.

Sincerely,

Prof. Warwick Sauer

Rhodes University

w.sauer@ru.ac.za

Development of Regional Ecosystem Monitoring Framework for WIO large marine ecosystem

1. Personal information
   1.1. Name _____
   1.2. Position and role _____
   1.3. Department/University/Institute _____

2. Please find attached a cover letter and summary of information on ecosystem monitoring programmes and indicators on the WIO region.

3. Is there a national plan to support monitoring programmes in your country? If yes, please provide the name of the plan(s) and importantly please attach the relevant documents with the questionnaire.

4. Are these monitoring programmes being implemented? If yes, please provide more information and please attach any relevant documents with the questionnaire.

5. Is there a national working group focused on monitoring in your country? If yes, please provide details and any relevant documents with the questionnaire.

6. Should you wish to please provide comments on priority ecosystem indicators and monitoring sites for your country and the WIO in general, and any other information you feel is relevant

Appendix 2. Summary of the responses to the ecosystem monitoring programme interview questionnaire.

Country	National plan to support monitoring	Implementation of monitoring programmes	National working group focused on monitoring in your country	Proposed indicators and monitoring sites
Madagascar	No real national plan yet supposed to be provided by the government, although monitoring programmes already exist for marine ecosystems	Yes, they are. marine protected areas, and particularly for our National Marine Parks, aerial surveillance programme for mangroves, Cetaceans and oceanographic data	No. This is something that the government should consider seriously in order to have a standardized monitoring protocol at national level.	
SA	No	Yes. See DEA Annual Ocean & Coasts Data Report and National Biodiversity Assessment (NBA) at SANBI website	No national working group but a few natural marine science monitoring government agencies. The National Department of Environment, Forestry & Fisheries (DEFF) convenes several fishery working groups, a marine top predators and a marine biodiversity working group	
Somalia	No	No	We have a National Development Plan (NDP) led by the Ministry of Planning and it has and M&E section	
Tanzania	No national plan to support monitoring programmes in Zanzibar	These monitoring programmes are not implemented	No national working group focused on monitoring in Zanzi-	

			bar. However, one of the current SWIOFish Project activity on Zanzibar part is to train Marine Conservation Area (MCA) staff on monitoring protocol for MCAs that is sufficiently simple and realistic as to be implemented with available human and financial resources, but which nonetheless generates useful management effectiveness data information	
	Yes. Small and pelagic management plan Tuna strategic management plan, Prawn management plan, Octopus management plan	They are partially implemented because some ecological information to support management of the marine resources are missing. Currently they are under review process. World Bank supported project SWIOFish (2015-2021) facilitates studies for five fisheries in Tanzania; Small pelagic fishery, Tuna and tuna like Fisheries, Shallow waters prawn fishery, Octopus fishery and Reef Fisheries. The objectives of SWIOFish is to make sure at the end of the project (June 2021) these studies provide information to improve/establish management plan for the fisheries. These studies are back stopped by WIOMSA. Most of	There is a coral reef task force under the Vice Present Office. The aim is to conduct coral reef monitoring along the coast of Tanzania	SST, Chl-a

		the supporting documents could be obtained from the Secretary of WIOMSA		
	any national monitoring programme except for the statistics data collection at fish at landing sites by the Department of Fisheries		No national working group for monitoring in Zanzibar We only do regular research. e.g. we collect data on octopus 14 days a month but after one year we will stop	Changu, Kwale, Bawe and Chumbe sites for Zanzibar

Annex 2. GUIDELINES FOR THE DEVELOPMENT OF NATIONAL ECOSYSTEM MONITORING PROGRAMMES IN THE WESTERN INDIAN OCEAN REGION

National Implementation modalities

Programme structure and initial preparation

Developing EMP involves two main processes: design and implementation. Ten steps are proposed here, distributed in four phases: setting objectives, design, implementation and review phases (Figure 1). The design process comprises the first two phases and the implementation process include the implementation and review phases.

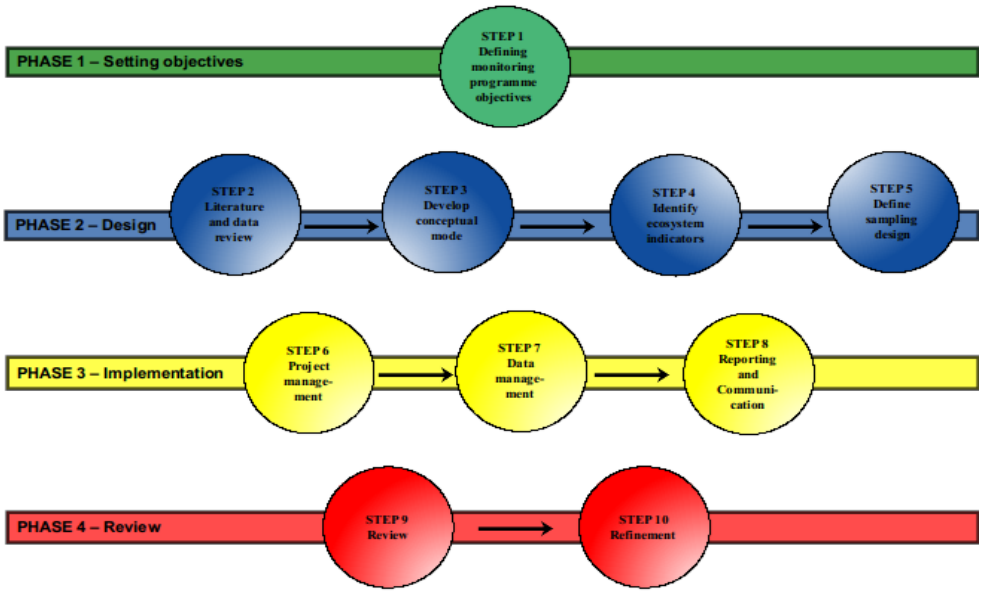

Figure 1. Development of National Ecosystem Monitoring Programmes.

Initial preparation of the programme team is indicated before starting the design process. A set of activities should be taken into consideration (CSIR, 2009): documentation of the design process; promotion of continuous participation of stakeholders at all steps; budgeting; identification of the design team. A record of all procedures and actions including all management, collection, analysis and storage techniques undertaken during the development of the EMP must be documented in order to identify gaps and best practices for future review and refinement of the process as well as to understand the rationale of all components of the process for a successful design and implementation of the programme. All steps and stages of the design process should consider co-participation and continuous interaction with stakeholders, addressing and considering their needs and concerns and that the design process under development is acceptable by all parties. Planning and execution of long-term ecosystem monitoring programmes is usually expensive,

especially when it encompasses large geographical coverage such as the WIOLME region requiring the identification of budget sources, availability and alternatives upfront for minimizing wastage of resources designing a monitoring programme of a scope that is unlikely to be funded or implemented. Another relevant aspect in preparing the design process is to set up the design team that comprises the programme manager and a group of scientists and experts with core skills and competencies, including oceanographic, ecological, biological, conservational, anthropological and economic qualifications. A rapid stakeholder analysis would then be crucial prior to the designating the design team.

The following questions (Table 1) will assist in determining the overall information needs of the design process for the development of the ecosystem monitoring programme at this initial and preparatory stage. Additional questions will be provided at each step as a guidance tool to proceed successfully throughout the design process.

Table 1. List of questions for overall information needs and actions in the preparation stage of the design process.

Questions	Yes	No
Have you defined the purposes (e.g. basic information, planning and policy, management and operational, regulation and compliance, resource assessment, or other purposes) of the new EMP?		
Has the design team been designated? Have you distributed their responsibilities?		
Are there available human and financial resources at your country for long-term monitoring?		
Have you identified the end users?		
Have you defined which ecosystem indicators will be measured and in what frequency?		
Will the monitoring data be used and published for scientific and decision-making purposes?		
Will the EMP support management decisions, ensure compliance with standards, identify priorities for action, provide early warning of future problems or detect gaps in current knowledge?		

Step 1 – Defining the programme objectives

The objectives of an EMP should be clear, concise and well defined to determine the type of data

that must be gathered and its utility. The formulation of the programme objectives will depend on the identification of related issues to be addressed in order to gather the required information. The issue is the major factor in determining whether a solution can be found. The definition of an issue, problem or question requires intensive participation of stakeholders and it is a result of their knowledge, experience and values. Stakeholders and end-users of the new EMP may include government authorities, non-governmental agencies, academic and research institutions, industries, communities, and regular citizens.

A results-based approach to monitoring is further indicated when setting up the objectives and should consider the outcomes of the Ecosystem Quality Objectives (EQO) and Targets and Management Action Plans for reaching up its informative role and providing a means of adapting and improving management programmes. In other words, besides providing its scientific-based foundation it should incorporate a management approach for future decision-making processes. Environmental Quality Objectives have also been identified in the ASCLME-SWIOFP TDA according to the main area of concern and thus should guide the management actions for implementing an ecosystem monitoring programme:

1. MAC 01 – Water Quality Degradation:

- Environmental flow requirements are taken into account for future development planning.
- Restore ground and surface water quality and prevent further degradation occurring in the future
- Reduce microbiological contamination in coastal waters
- Reduce solid waste (marine debris) from shipping and land-based sources in coastal water
- Develop the capacity to prevent and mitigate the effects of oil spills at regional and national level.

2. MAC 02 – Habitat and Community Modification:

- Effective mitigation and management of shoreline change.
- Status and ecosystem services of coastal habitats protected and effectively managed
- Mangrove habitats sustainably managed and the health and ecosystem services protected
- Corals reef health and ecosystem services protected and sustainably managed
- Seagrass habitats sustainably managed and the health and ecosystem services protected

- Watersheds ecosystem protected, rehabilitated, ecosystem function restored, and sustainably managed
- Health and ecosystem services of deep-water habitats protected and effectively managed
- Eliminate or minimize the risk of the introduction or spread of exotic non-native species, invasive and nuisance species.

3. MAC 03 – Declines in Living Marine Resources:

- Restoring the populations of sharks and rays to sustainable levels
- Contributing to the rebuilding/restoration of the populations of large pelagics to sustainable levels
- Rebuilding and restoration of the populations of small pelagic species to sustainable levels
- Rebuilding and restoration of the populations of reef and demersal fish species to sustainable levels
- Rebuilding and restoration of the populations of sea cucumber species to sustainable levels
- Rebuilding and restoration of the populations of prawns and shrimps fisheries to sustainable levels
- Rebuilding and restoration of the populations of lobster species to sustainable levels
- Maximise the value of bycatch and eliminate discards

4. MAC 04 – Environmental Variability and Extreme Events:

- As the main issues of concern of this area are of long-term nature, EQOs were not identified in the TDA/SAP. Revealing the potential trends and effects of these issue are largely relevant to EMP.

Step 2 – Literature and data review

A comprehensive literature review of the study area, available data and previous monitoring programmes is relevant to identify concerns, and generate insights to the design process, provide guidance on the type of scientific data must be gathered, and avoid duplicate efforts and mistakes. It is also useful for identifying knowledge gaps and revealing limitations and restrictions of not having the required information assessed. For the WIOLME, existing data are available in scientific publications and technical reports or databases. These are related to biological

information, ecosystem functioning, structure and biodiversity, oceanographic measurements and fisheries statistical records, socio-economic information, existing management and institutional arrangements.

Step 3 – Develop a conceptual mode

Features, processes and management challenges of a large marine ecosystem may be outlined through the development of a conceptual mode, which consist of concise and visually-stimulating illustrations. The development of a conceptual mode should engage the whole design team working closely in order to illustrate how the monitoring site functions and identify the dominant processes and factors that are behind changes in their natural variability. The conceptual mode does not have to be extensive and encompass all the ecosystem features and processes. Essentially, it has to incorporate the components of the ecosystem, key process involved, cause-effect relationships, spatial boundaries, site selection, indicators to be measured, temporal considerations and questions to be answered that are suitable for the issues, problems or questions concerned in the monitoring programme. Components of the ecosystem in the WIOLME would involve ocean topology, marine biota, and abiotic factors. Common key biological, physical and chemical processes, for instance, include coastal circulation, upwelling, monsoons, mixing, ocean primary productivity, filtration, trophodynamics, carbon sequestration.

The conceptual mode is useful for facilitating communication, integrating knowledge across disciplines, improving understanding, identifying knowledge gaps, guiding decision making and planning, and stimulating participation of stakeholders. The validation of the assumptions underlined in the conceptual mode are also a key component in determining the objectives of the EMP through, for instance, the collection of novel data. That means, that the development of the conceptual mode is valuable and may be applied at the initial stages of the design process. Also, a conceptual model may adapt with the time to incorporate newly collected or reviewed information. An example of a conceptual mode for the WIOLME is represented in Figure 2 below using the top priority issue "*2.2.6 disturbance, change and loss of mangrove habitats*" as pointed out in the TDA for the ASCLME-SWIOFP for the *MAC Habitat and Community Modification*.

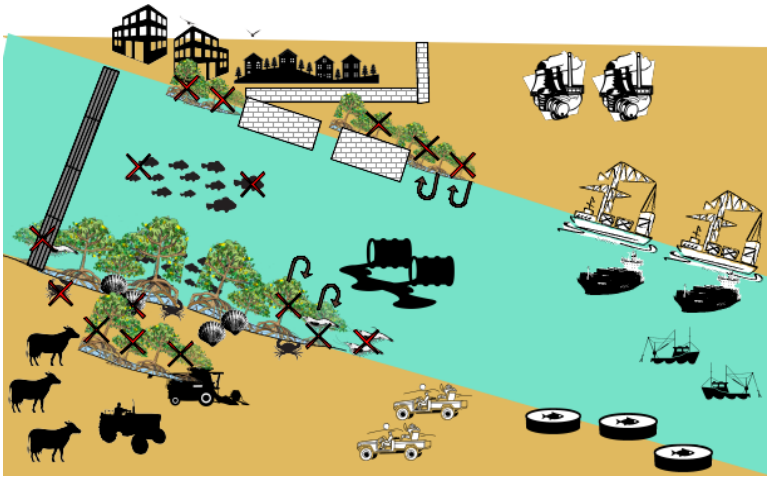

Figure 2. Conceptual model of disturbance, change and loss to mangrove forests. red cross: habitat/diversity loss; brown arrow: increased sedimentation**.**

Step 4 – Identify ecosystem indicators

Ecosystem indicators to be measured in the EMP represent those in which environmental, fisheries and socio-economical data may be quantified and reproduced in a long-term. These will be directly linked to the objectives of the programme. Selection of ecosystem indicators is the backbone of a successful ecosystem monitoring programme.

The selection criteria include but are not limited to relevance, validity, diagnostic value, responsiveness, reliability and appropriateness (Table 2) when it comes to national monitoring. These indicators will provide characteristics of the marine ecosystem health, anticipate impacts (e.g. anthropogenic, natural), consider the expenses involved with the collection, measurement and analyses, and also reflect the natural variability of the region in order to predict and detect environmental and socio-economic changes. The indicator themes herein defined as environment, fisheries and socio-economic, when combined, offer an overall impression of the ecosystem health and its related ecosystem services to society in the WIOLME, addressing risks and rapidly responding to potential negative impacts.

Table 2. Criteria for the selection of ecosystem indicators (adapted from ANZECC and ARMCANZ 2000).

Criteria	**Question**
Relevance	Does the indicator reflect the issue/problem of concern?

Validity	Can the indicator be tested and explain the changes in the ecosystem?
Diagnostic value	Can the changes detected by the indicators be expressed quantitatively and qualitatively?
Responsiveness	Can the indicators work as an early warning system for immediate management mitigation? Can it reflect changes to these management interventions?
Reliability	Can the indicator be measured in reliable, reproducible and cost-effective system?
Appropriateness	Is the indicator appropriate for the proposed spatial and temporal scales of the monitoring?

Environmental indicators involve biological, physical and chemical analyses and may be determined through specific ecological surveys in the field and laboratory. Key indicators to monitor environmental variability include seawater temperature, pH, oxygen, primary and secondary productivity. Fisheries indicators will also include some biological data (e.g. biomass, diet composition, abundance of key species, genetic isolation) but mainly comprise fisheries data. Socio-economic indicators, on the other hand, represent parameters in which changes in society result directly from effects of the impact in the environment and fisheries activities. Examples of these indicators are employment rate, fisheries production/export, and gender empowerment, and, thus, include economic and anthropological data.

4.1 Methodology for the selection of Regional Indicators

A methodology has been created to select the appropriate indicators that suits the needs and issues of the WIOLME. Taking into account the general outline provided above, the key criterion for the pre-selection of indicators applied here is "*Appropriateness*" defined as alignment of indicators with the aims of this Regional Framework, which is to provide support to the WIO countries and the region on how to implement regional monitoring and assess progress towards global commitments such as the SDGs, the Aichi Targets and the post-2020 Biodiversity Framework. A set of stages has then been undertaken in order to get into a final list of priority indicators, which are suggested for inclusion in the Regional EMP:

- Stage 1 – Alignment with Frameworks Aims: An assessment of the aims of several regional and global commitments such as the UNEP Regional Seas Programme using the Regional Seas Strategic Directive 2017-2020 , the Ocean Decade, a number of SDG (6, 13 and 14) and Aichi Targets was conducted. The common themes among the frameworks were to reduce pollution,

increase the resilience of ecosystems and dependent communities, the protection of critical habitats (MPA coverage) and provision of ecosystem services. The indicators from the United Nations Framework Convention on Climate Change (UNFCCC) were also considered for inclusion in our analysis, these indicators are under evaluation and awaiting final selection. A list consisting of 12 UNFCCC indicators has been made available[35] and was incorporated in the present EMP. These 12 indicators have a link to the SDG targets, since the SDG targets and indicators have already been reviewed against the aims of the Ocean Decade and Regional Seas Strategic Directive 2017–2020 and selected based on their relevance, the UNFCCC indicators were not further considered.

Eighty-five candidate indicators were selected after the assessment. These candidate indicators overlap with the core indicators from other frameworks including the Regional Seas, Large Marine Ecosystem and Transboundary Water Assessment Programme among others.

- Stage 2 – Selection criteria: To prioritize the most relevant indicators for the region a total of seven criteria were chosen and applied. These criteria are defined as follow:

1. *Coverage*: The indicator is already available today or under active development in at least one WIO country.
2. *Linked to the Transboundary Diagnostic Analysis*: There is a clear direct or indirect link to one of the 21 High transboundary priority issues identified on the TDA of the WIOLME.
3. *Easy to communicate*
4. *Practicability*: Indicator is widely available and implemented in at least one WIO country and may be expanded to others without requiring expensive infrastructure or significant additional capacity.
5. *Scientifically sound*[36]: Indicator is based on clearly defined, verifiable and scientifically acceptable data, which are collected using standard methods and definitions with known accuracy and precision, or based on traditional knowledge that has been validated in an appropriate way. All underlying data sources must be used in compliance with any associated terms of use, with clear acknowledgements of the source. Otherwise, the indicators must be peer-reviewed in scientific literature or accepted by an intergovernmental body, such as the Inter-Agency Expert Group for

[35] https://unfccc.int/sites/default/files/resource/3_UNSD_AdaptationPresentation_25July2018.pdf accessed 13/20/2020

[36] Indicators for Global and National Biodiversity Targets – Experience and Indicator Resources for Development of The Post- 2020 Global Biodiversity Framework

the Sustainable Development Goals (IAEG-SDGs).

6. *Relevance to Policy*: Indicator is relevant to one or more of the Aichi Biodiversity Targets or other frameworks including the SDGs or the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). An important criterion is that the indicator has already been used for decision-making or on global/regional reporting frameworks like the Global Biodiversity Outlook.

7. *Flexibility*: The indicator can be disaggregated to create national indicator or is aggregated from national data to form a regional indicator.

- Stage 3 – Scoring of indicators: The data sources used to score these indicators are the SDGs database, Indicators for the Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets and the TDA. The *"Easy to communicate*" category was available for the Aichi Targets but not for the SDGs indicators, thus the score was based on the complexity of the indicator. For instance, involving specific terminology or concepts difficult to explain to the layman. All seven criteria were scored for all 85 potential indicators, a value of 1 was given if the indicator fulfils the criteria or 0 if it does not. No higher weightings were assigned to any specific criteria. A maximum score of 7 was obtained if the indicator fulfils all the criteria. Indicators with the highest scores (5–7) are considered priority indicators and went through evaluation by a panel of local experts. Duplicate indicators were removed.

The priority indicators cover themes as biodiversity, ecosystems, impacts of human activities on ecosystems but they do not cover physical processes in detail. To correct this and account for a full ecosystem monitoring, the essential ocean variables (EOV) of the Global Ocean Observing System[37] were also evaluated. A total of 30 EOVs are available and there is overlap between the EOVs on the biology and ecosystem, and biogeochemistry categories and the priority indicators selected here. However, 10 EOVs from the physics category were not considered and are recommended for inclusion. These are sea state, ocean surface stress, sea surface height, sea surface temperature, subsurface temperature, surface currents, subsurface currents, sea surface salinity, subsurface salinity and ocean surface heat flux.

Overall, thirty priority indicators were selected for the region based on their scores (see

[37] https://www.goosocean.org

complete list of priority indicators in Appendix 2). The results are presented with a view to a review by the SAPPHIRE team, and any adjustment of the indicators before finalization.

Step 5 – Define sampling design

Sampling design consists of a sampling strategy in which long-term monitoring data will be collected, measured and analyzed during a certain time frame, frequency, quantity and location. The following aspects of the sampling design must be predetermined: 1. identification and delimitation of the monitoring site(s) and sampling stations; 2. frequency and timing; 3. quantity of samples; 4. data collection and analyses methods; 5. required resources and facilities.

WIOLME encompasses a wide and diverse region with countless and unique coastal, oceanic and estuarine habitats of cultural, economic and ecological value. For the EMP, it would be impossible to acquire and manage human resources and funding for all these sites. Thus, site selection is crucial for focusing on important efforts and direct appropriate investments. Usually, the main criteria for site selection is to take into account the environmental characteristics of the WIOLME such us upwelling, endemism etc. Secondly, a risk or socio-economic assessment of certain sites may indicate which ones should be prioritized. Another relevant criterion is accessibility to the monitoring site and safety under normal conditions. Prioritization of sites may be efficient to start up the EMP and a ranking system may assist with the identification of priority sites. Here, six criteria for prioritization are suggested for the region and their respective rating is given below following Cilliers and Adams (2016) (Table 3).

Table 3. Criteria and rating for prioritization of site selection in EMP (adapted from Cilliers and Adams, 2016).

Criteria	Rating
Practicality (A) The monitoring programme is volunteer-based and therefore depends on the availability of human resources on a specific site to undertake the sampling.	1 – Impractical 2 – Possible 3 – Highly practical
Current state (B) The site may be important to monitor because of its pristine state (current and/or historic ecological state) and may be based on available baseline environmental assessments.	1 – Highly degraded 2 – Fair/good 3 – Pristine
Ecological importance (C) The ecological importance of the site is based on a local, regional or national level and should be based on data from available literature.	1 – Low 2 – Medium 3 – High
Socio-economic importance (D)	1 – Low 2 – Medium 3 – High

This entails the importance of sites to provide economic opportunity in the form of industry and associated maritime development (D1), tourism/recreation (D2), and subsistence fisheries (D3) on a national scale. It should consider the results from TDA/MEDA for the ASCLME-SWIOFP.	
Future impacts (E) Future environmental impacts relate to the likelihood of development pressure increasing in the future on a specific site through urban development, tourism, industry and subsistence fisheries, and are based on professional opinion and/or available literature.	1 – Low 2 – Medium 3 – High
Level of available data (F) Sites where a low level of data is available merit the establishment of a monitoring programme to address this inadequacy. In certain instances a site may have a high level of data available, but, due to current and future pressures (e.g. pollution, development pressure) and/or its national importance, there is merit in building on this existing data. In these instances separate motivation for prioritizing a specific sites should be provided.	3 – Low 2 – Moderate 1 – Excellent

Critical habitats have been listed in the WIOLME and may be incorporated into the new EMP such as the coral reef fields including the coral triangle hotspot located between eastern Africa, northern tip of Madagascar and its associated islands, seagrass meadows including the hotspots of Inhaca Island and Bazaruto Archipelago, mangrove forests, offshore banks and deep sea habitats. These critical habitats has been clearly available when evaluating the state of monitoring sites in countries of the region and their relation to the regional priority issues (Table 4).

Table 4. Existing national monitoring programmes related to the high priority transboundary issues in the WIOLME (modified from ASCLME/SWIOFP 2012). Abbreviations: Y; yes, operational; N: no monitoring (highlighted in red); L: limited to site specific or periodic; NR: not relevant; ?: unknown.

Main Area of Concern	Issue No	Issue category	Comoros	Kenya	Madagascar	Mauritius	Mozambique	Seychelles	Somalia	South Africa	Tanzania
MAC01 Water Quality Degradation	1.1	alteration of natural river flow and changes in freshwater input and sediment load	Y	N	N	?	Y	Y	Y	Y	L
	1.2	degradation of ground surface water quality	L	N	N	Y	Y	N	Y	Y	L
	1.3.1	microbiological contamination from land-based and marine sources (1.3.1);	N	N	N	L	L	N	N	L	L
	1.3.5	solid wastes/marine debris from	L	N	Y	N	N	N	N	L	L

	1.3.6	shipping and land-based-sources oil spills (drilling, exploitation, transport, processing, storage, shipping)	N	N	Y	N	Y	N	N	N	L
MAC02 Habitat and Community Modification	2.1	shoreline change due to modification, land reclamation and coastal erosion	N	Y	N	L	L	Y	N	N	L
	2.2.1	disturbance, damage and loss of upland. watershed habitats (>10m elevation)	N	N	?	L	Y	NR	?	Y	?
	2.2.3	disturbance, damage and loss of coastal vegetation and flood plan habitats ((beaches, dunes, coastal vegetation and flood plain habitats to 10 m elevation)	N	Y	?	N	L	N	N	N	?
	2.2.6	disturbance, damage and loss of mangrove habitats	N	N	Y	Y	L	Y	N	N	?
	2.3.1	disturbance, damage and loss of coral reef habitats	?	Y	Y	Y	L	Y	N	N	Y
	2.3.2	disturbance, damage and loss of seagrass habitats	?	L	Y	N	L	N	N	N	Y
	2.3.5	disturbance, damage and loss of deep-water habitats (including sea mounts)	NR	?	?	NR	NR	NR	N	N	N
	2.6	introduction of exotic non-native species, invasive and nuisance species	?	Y	N	Y	N	NR	N	N	?
MAC03 Declines in Living Marine Resources	3.2.1	decline in populations of sharks and rays	N	L	N	Y	N	N	N	Y	NR
	3.2.2	decline in populations of large pelagics	Y	?	Y	Y	L	Y	Y	Y	N
	3.2.3	decline in populations of small pelagics	N	?	Y	NR	L	NR	N	Y	L
	3.2.5	decline in populations of reef and demersal fish	N	Y	Y	Y	L	Y	N	Y	L

3.3.3	decline in populations of sea cucumbers	N	?	N	Y	N	Y	N	NR	L	
3.3.4	decline in populations of prawns and shrimp	N	Y	Y	Y	Y	NR	N	Y	L	
3.3.5	decline in populations of lobsters	NR	L	Y	Y	L	Y	Y	NR	L	
3.4	excessive bycatch and discards	N	L	Y	Y	Y	N	N	Y	L	

Sampling frequency (e.g. weekly, daily, annually) depends on the main objective of the EMP. In the case of large marine ecosystems such as the present subject region of this guideline, the frequency and timing must consider the high temporal and spatial variability of the ecosystem for resolving the natural parameter of the indicator under investigation. Also, the natural variability of the environment must be distinguished from the long-term human-driven interference and in order to minimize the risk of misinterpretation and seasonal uncertainties should consider a narrow time-frame each year. A considerable number of samples are required in the EMP of the WIOLME but it may vary at each monitoring station or interval. In terms of the methodology, the type of monitoring dictates the methods for data analysis. In this case, data assessments may consider the trends and changes over long periods of time (trend monitoring), the relationships such as significance and differences between the measured variables (impact monitoring), and the extend to which fisheries, environmental and socio-economic indicators are in compliance with guidelines, criteria and objectives. Availability of resources and facilities as well as personnel, equipment and funding are also relevant in the design process as these aspects play a role in the effectiveness and success of both design and implementation process.

Step 6. Project management

An implementation process is a work plan that contains information on the project, expected outcomes, a timeline, responsible agents and the resources needed (Levin et al., 2018). This step is key since without an implementation plan, the EMP will not achieve their desired outcomes. The design team has the responsibility to oversee the plan implementation being essentially relevant to include and work with all relevant agencies/ministries. Since governments are mostly structured into sectors (e.g. fishing, mining, etc), an EMP will encompass the competencies of different sectors (Staples et al., 2014).

Most of the countries in the WIOLME do not have comprehensive monitoring programmes

as seen in the Table 4 above, and in most cases, these focus on fisheries statistics for the main commercial fisheries or on specific critical habitats (i.e. corals). An ecosystem monitoring programme must include information on the status of species, habitats and environmental conditions in the biophysical system and associated human system (Heenan et al., 2016), thus ranging from water quality to top predators to dependent resource users. In the region, South Africa has the highest number of monitoring initiatives, still many of them are based on specific sectors and do not integrate different aspects of the ecosystem (with a few exceptions).

6.1 Planning the EMP implementation

The priority issues (identified in the EMP) have been linked to regional indicators and actions, and will be used as the basis to determine (Source: Staples et al, 2014, Levin et al., 2018):

- What are the specific tasks that need to be conducted?
- What institutions and personnel will be responsible for completing the tasks?
- How it will be achieved?
- What is the cost of implementing the monitoring programme? And how it will be funded?
- What are the expected outcomes?
- When the tasks will be done?
- Are there existing related projects? If yes, how synergies can be created?

A self-assessment template has been prepared to aid with prioritizing regional indicators and planning implementation (Annex 3), a summary version of this template can be found in Table 5.

Table 5. Summary version of the self-assessment template for national data reporting on the Ecosystem monitoring of the Western Indian Ocean

Priority Indicator	**Name and Institution of the indicator coordinator**	**Name of expert group involved**	**Indicator review and evaluation**		**Required monitoring progress**	**Data availability**	**Site name**	**Frequency of data collection**
			Frequency	**Date of latest review**				

6.3.1 Proportion of wastewater safely treated								

Coordination and collaboration among institutions is key to implement the EMP, and it is essential that each agency has a clearly defined role and responsibility to avoid overlaps on functions or ineffective action. The buy-in from government institutions and key stakeholders is crucial to ensure implementation. Table 6 describes a set of principles needed to achieve effective monitoring in marine systems.

Table 6. The essential elements of an efficient and effective marine monitoring programme (Source: Turrell, 2018).

Governance	An easily understood, visible **governance structure** involving all relevant stakeholders (with published purpose, terms of reference and minutes), consisting of leadership, managerial and operational levels.
Strategy and Work Plan	A published **monitoring strategy** which describes the purpose and objectives of the thematic monitoring
	A published **monitoring plan** used to coordinate within-agency and inter-agency resources
	A **"fit for purpose" analysis** of the monitoring plan (i.e. an assessment of what minimum programme may still meet the monitoring strategic objectives)
Sampling	Agreed and published **sampling protocols**
	Agreed and published **quality assurance processes**
Data	**Shared data centres** which facilitate 'collect once, use many times'
Assessment	Published and **peer-reviewed assessment models/processes**
	Published **assessment outcomes**

6.2 Conducting a fit-for-purpose analysis

The "fit-for-purpose" analysis aims to determine if the monitoring programme is meeting its objectives and how to optimize resources while still conducting an effective monitoring (Turrell, 2018). This analysis ranges from qualitative approaches for the early stages of monitoring programmes to quantitative approaches for established and developed programmes (Turrell, 2018).

Step 7. Data management

Thirty priority indicators were selected based on their alignment with global and regional commitments and the criteria listed in step 4. Most priority indicators are used in global reporting schemes such as the Sustainable Development Goals, Aichi Targets, post-2020 global biodiversity framework and thus, there are established guidelines and/or step-by-step methodologies developed for these indicators. A summary of the methodologies for each of these indicators grouped

according to the MACs can be found below.

7.1.1 Water Quality Degradation

- *SDG 6.3.1 Proportion of domestic and industrial wastewater flows safely treated*

Progress on Wastewater Treatment – Piloting the monitoring methodology and initial findings for SDG indicator 6.3.1
https://www.unwater.org/app/uploads/2018/12/SDG6_Indicator_Report_631_Progress-on-Wastewater-Treatment_ENGLISH_2018.pdf
Step-By-Step Monitoring Methodology for Indicator 6.3.1
https://www.who.int/water_sanitation_health/monitoring/coverage/stepbystep-631-20161021.pdf?ua=1

- *SDG 6.3.2, GBF 10.3 Proportion of bodies of water with good ambient water quality*

Step-By-Step Monitoring Methodology for Indicator 6.3.2
https://seea.un.org/sites/seea.un.org/files/annex_7a._indicator_6.3.2_methodology.pdf

- *SDG 14.1.1 Index of coastal eutrophication and plastic debris density*

Indicator 14.1.1 metadata
https://environmentlive.unep.org/media/docs/projects/metadata_14_01_01.pdf

- *SDG 6.5.1 Degree of integrated water resources management*

Monitoring guide for SDG 6.5.1
http://iwrmdataportal.unepdhi.org/IWRMDataJsonService/Service1.svc/DownloadSurveyDocument/English/Monitoring_Guide_Final/docx
Country instrument
http://iwrmdataportal.unepdhi.org/IWRMDataJsonService/Service1.svc/DownloadSurveyDocument/English/IWRM_Survey_Final/docx
more information including country database
http://iwrmdataportal.unepdhi.org

7.1.2 Habitat and Community Modification

- *GBF 2.3 Proportion of terrestrial, freshwater and marine ecological regions which are conserved by PAs or OECMs*

Quick guide

https://www.cbd.int/doc/strategic-plan/targets/T6-quick-guide-en.pdf

- *GBF 1.2. Trend in mangrove extent, Mangrove cover and composition (EOV)*

EOV Spec sheet: Mangrove Cover and Composition
https://www.goosocean.org/components/com_oe/oe.php?task=download&id=40002&version=1.0&lang=1&format=17

- *Seagrass cover and composition (EOV)*

EOV Spec sheet: Seagrass Cover and Composition
https://www.goosocean.org/index.php?option=com_oe&task=viewDocumentRecord&docID=17513

- *GBF 1.2 Trend in proportion of live coral cover, Hard coral cover and composition (EOV)*

EOV Spec sheet: Hard coral Cover and Composition
https://www.goosocean.org/index.php?option=com_oe&task=viewDocumentRecord&docID=17512

- *SDG 14.5.1, GBF 2.1 Coverage of protected areas in relation to marine areas*

Indicator 14.5.1 metadata
https://unstats.un.org/sdgs/metadata/files/Metadata-14-05-01.pdf

- *SDG 15.8 Proportion of countries adopting relevant national legislation and adequately resourcing the prevention or control of invasive alien species*

Indicator 15.8.1 metadata
https://unstats.un.org/sdgs/metadata/files/Metadata-15-08-01.pdf

- *AT 11 Management effectiveness of protected areas (IPBES core indicator)*

Global Database on Protected Area Management Effectiveness (PAME) User Manual 1.0
https://wdpa.s3.amazonaws.com/PAME/PAME_manual/English/GD-PAME_manual_v1_EN.pdf
Managing protected areas: A toolkit for the Western Indian Ocean
https://www.wiomsa.org/mpatoolkit/
List of methodologies on the Global database on PAME
https://www.protectedplanet.net/en/thematic-areas/protected-areas-management-effectiveness-pame
For more information and updated manuals:
https://www.protectedplanet.net/en/thematic-areas/protected-areas-management-effectiveness-pame

7.1.3 Declines in Living Marine Resources

- *SDG 14.4.1 Proportion of fish stocks within biologically sustainable levels*

Indicator 14.4.1 metadata

https://unstats.un.org/sdgs/metadata/files/Metadata-14-04-01.pdf

- *SDG 14.2.1, GBF 1.1 Number of countries using ecosystem-based approaches to managing marine areas*

Work plan Indicator 14.2.1

https://unstats.un.org/sdgs/tierIII-indicators/files/Tier3-14-02-01.pdf

- *GBF 1.2, 1.4 Ocean Health Index*

Ocean Health Index 2018: methods

https://knb.ecoinformatics.org/knb/d1/mn/v2/object/urn%3Auuid%3A01100e5e-b578-446b-b433-6a34c905b152#5_goal_models_and_data

- *AT 6 Estimated fisheries catch and fishing efforts (IPBES core indicator)*

Tools – Fisheries catch reconstruction

https://ipbes.net/policy-support/tools-instruments/fisheries-catch-reconstruction

More information

http://www.seaaroundus.org/catch-reconstruction-and-allocation-methods/

https://www.nature.com/articles/ncomms10244

- *AT 6 Number of countries with policies that make adequate provisions to minimize the impacts of fisheries on threatened species*
- *AT 6 Number of countries with regulations requiring recovery of depleted species*
- *AT 6 Number of countries with policies to secure that mortalities and significant indirect adverse impacts on non-target species are accounted for*
- *AT 6 Proportion of depleted stocks with rebuilding plans in place*
- *AT 6 Proportion of fisheries with regular monitoring and reporting of impacts on threatened species*

For information on Aichi target 6 indicators:

Garcia, S.M. and Rice, J. *Assessing Progress towards Aichi Biodiversity Target 6 on Sustainable Marine Fisheries*. Technical Series No. 87. Secretariat of the Convention on Biological Diversity, Montreal, 103 pages

https://www.cbd.int/doc/publications/cbd-ts-87-en.pdf

- *SDG 14.b.1, GBF 8.1. Degree of application of a legal/regulatory/policy/institutional framework which recognizes and protects access rights for small-scale fisheries*

Indicator 14.b.1 metadata
https://unstats.un.org/sdgs/metadata/files/Metadata-14-0b-01.pdf
Database
https://sdlc.fao.org/artifactory/fao-sdg-releases/14.b.1/14_b_1_DataExport_June_2020.xlsx
More information
http://www.fao.org/sustainable-development-goals/indicators/14b1/en/

- *AT 18 Number of local community-based monitoring on traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity*

Traditional Knowledge Information Portal
https://www.cbd.int/tk/

- *SDG 14.6.1, GBF 4.1, 8.1 Degree of implementation of international instruments aiming to combat illegal, unreported and unregulated fishing*

Indicator 14.6.1 metadata
https://unstats.un.org/sdgs/metadata/files/Metadata-14-06-01.pdf

- *Fish abundance and distribution (EOV)*

EOV Spec sheet: Fish abundance and distribution
https://www.goosocean.org/index.php?option=com_oe&task=viewDocumentRecord&docID=17510

- *Marine turtles, birds, mammals abundance and distribution (EOV)*

EOV Spec sheet: Marine turtles, birds, mammals abundance and distribution
https://www.goosocean.org/components/com_oe/oe.php?task=download&id=38710&version=1.0&lang=1&format=1

- *Invertebrate abundance and distribution (EOV)*
  Under development

7.1.4 Environmental Variability and Extreme Events

- SDG 13.1.2, GBF 7.1 Number of countries that adopt and implement national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015–2030

Indicator 13.1.2 metadata

https://unstats.un.org/sdgs/metadata/files/Metadata-13-01-02.pdf

- SDG 13.1.3, GBF 7.1 Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national disaster risk reduction strategies

Indicator 13.1.3 metadata

https://unstats.un.org/sdgs/metadata/files/Metadata-13-01-03.pdf

7.2 Data quality assurance processes

The United Nations 'National Quality Assurance Frameworks Manual for Official Statistics'[38] was developed to provide recommendations, a framework and implementation guidelines to enable the development of national quality assurance frameworks in countries worldwide. A Workshop on the 'Implementation of a National Quality Assurance Framework for Official Statistics in countries of the Africa Region' took place in 2019 with the aim to train participants from national statistical offices on quality assurance and the development of national frameworks. The African Statistical Commission was scheduled to meet in October 2020 to discuss progress on the implementation of national quality assurance frameworks in the continent. The National Data Centers should organize a meeting with the expert groups involved and data producers of each indicator to coordinate and discuss the implementation of the data quality assurance process.

7.3. Data center

The Nairobi Convention (NC) Clearinghouse mechanism is a 'data reference centre' allowing data and information sharing for the WIO region. This mechanism supports sustainable development, and the management and conservation of coastal and marine environments in the region. The objectives of the NC clearinghouse mechanism are[39]:

[38] https://unstats.un.org/unsd/methodology/dataquality/references/1902216-UNNQAFManual-WEB.pdf accessed 15/12/2020.

[39] https://nairobiconvention.org/clearinghouse/about#:~:text=The%20Nairobi%20Convention%20Clearinghouse%20is,the%20Western%20Indian%20Ocean%20region.

1. Development of human resource capacities and appropriate information infrastructure at national level

2. Development of an enabling environment for assessment through advocacy of standards

3. Access to relevant data and information on the coastal and marine environment.

The NC clearinghouse mechanism has a number of capabilities including mapping services, a data dashboard and catalogue. The mechanism is linked to the National Data Centres of all the Contracting parties to enable data sharing, exchange and dissemination. Each National Data Centre will prepare and submit their relevant monitoring data to the Nairobi Clearinghouse Mechanism. The reporting frequency will be decided between the working groups and the National Data Centres, and will most likely be annual or bi-annual.

Step 8. Reporting and communication

The monitoring strategy and implementation process will need to be validated by stakeholders in order to obtain their buy-in. A formal consultation process must take place with the relevant authorities and stakeholders, and both strategy and process must be made publicly available for consultation. Workshops organized by the design team or alternatively an implementation task team may be used during the consultation process. The design team must publicly acknowledge all the comments received for the strategy and process, and ensure those comments are integrated.

Based on our analysis, there is no evidence of existing ecosystem monitoring programmes in the WIO region thus policy interventions will be required to ensure the implementation of the EMP. Once the EMP has been finalized, the responsible agency must inform the public of the plan approval. Some important considerations when communicating the monitoring strategy are (FAO, 2014):

- *Who needs to know about the EMP and why?*
- *What communication format is appropriate for different target audience types: formal*
- *report, newsletter, website, etc.?*
- *What should the frequency of the communication products be for each audience?*
- *What should the report contain: information on successes and failures; progress?*

Accessed on 14/12/2020

- *What action is expected from the audience in return?*
- *What impact are the reports expected to have: the raising of awareness; institutional*
- *response?*
- *How to get feedback from the reports?*

Step. 9 Review of the programme

The design team which includes representatives from key stakeholder groups must coordinate data collection and analysis of the management performance. A fit-for-purpose analysis must be conducted to determine if the EMP is running efficiently and achieving its objectives. The design team must regularly evaluate the progress of the EMP to enable its continuous and adaptive improvement. General guidelines on how to review the progress of the EMP will be provided.

Step 10. Refinement of the EMP

Monitoring programmes require reviewing and refinement on a regular basis through short (yearly) and long-term (every three or five years) analyses that must be scheduled to improve the EMP if necessary. The design team should coordinate this step together with independent teams/organizations to ensure transparency.

Conclusions and Recommendations

The step-by-step guideline provided in this document consists of a suggested methodology for the design and implementation processes of national ecosystem monitoring programmes in the Western Indian Ocean Large Marine Ecosystem. Because ecosystem monitoring is of long-term nature that requires adaptive actions the suggested guideline may change and/or must be revised according to specific country interests.

The current guideline is based on previous published methodology on the development of monitoring programmes and thus it has not yet incorporated the views and needs of specific stakeholders for a proactive development. This must be addressed and refined through future workshops related to the subject. Co-participation represents a relevant component on the development of this framework, especially for the identification of appropriate ecosystem indicators as well as in the recommendation of standard methodologies to be applied for data gathering of ecosystem indicators in order to guarantee that the data are reproducible and comparable throughout the years. This document thus does not fully address all the criteria to the

design process of specific sites (e.g. mangroves, coral reefs, offshore banks) as the LME in question is a highly diverse and complex region.

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ECOSYSTEM MONITORING PROGRAMME TEMPLATE

Step 1 – Definition of programme objectives

- What are the issues/problem/question in concern?
- Is the new EMP of your country going to inform national management planning?
- Is the new EMP going to be part of a regional monitoring initiative?
- Is the new EMP address the interest of a variety of stakeholders?

Checklist	Yes	No
Did you define the issue(s), problem, or question in concern?		
Have you involved stakeholder co-participation in setting objectives?		
Have you applied an outcome approach (versus output approach) in setting up objectives?		
Can the objectives be translated into testable hypothesis?		
Do the objectives provide a management-based foundation besides a scientific approach?		

Step 2 – Literature review

Checklist	Yes	No
Have all the related information been collected, compiled, and revised?		
Are the collected information organized into a single spreadsheet for comparative purposes?		
Have knowledge gaps been identified?		
Are there any information that not being able to be assessed that may indicate limitations and restrictions?		

Step 3 – Developing a conceptual model

- What is the issue/problem of concern?
- What type of marine habitat should the model describe and what are its geographical limits?
- What key biological, physical and chemical processes and relationships have you identified?
- What are the essential components of the ecosystem to be monitored?
- Have the assumptions underlying the model been made explicit?

Step 4 – Identification of ecosystem indicators

- Did the selection of the indicators follow the criteria below?

Criteria checklist	Yes	No
Relevance		
Validity		
Diagnostic value		
Responsiveness		
Reliability		
Appropriateness		

Step 5 – Definition of sampling design

- Have the study type/scope (e.g. descriptive, qualitative) been defined?
- Have the study sites been selected? Are they safe and accessible?
- What the scale (e.g. spatial, temporal) of the study been delimited?
- How long/frequency the study will be implemented?
- Have the sampling stations been selected to accommodate the natural variability?
- Is the study cost-effective?
- Have the methods for collection and analysis been examined?

Methods	**References**	**Timing (frequency of sampling)**	**Task responsibility/ participation**