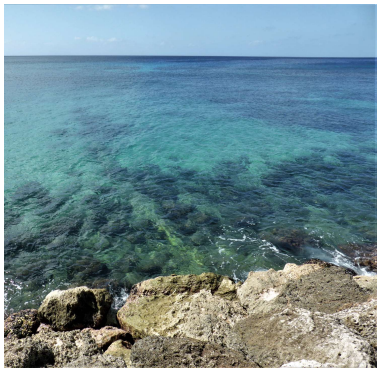

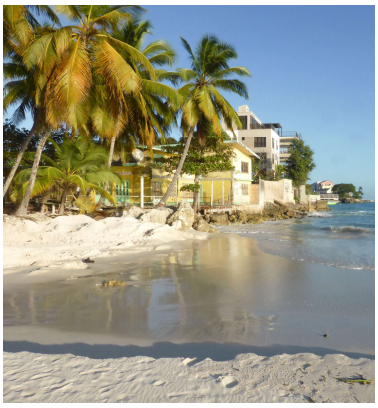

DEVELOPMENT OF A MARINE POLLUTION MANAGEMENT STRATEGY AND ACTION PLAN IN BARBADOS

to promote the preservation of marine habitats, marine ecosystem services, healthy ocean space and sustainable marine-based livelihoods

Deliverable 3 – Marine Pollution Management Methods and Tools Review Report

D3_t22065/01 – May 2023

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Consultancy Services for the Development of a Marine Pollution Management Strategy and Action Plan in Barbados to promote the preservation of marine habitats, marine ecosystem services, healthy ocean space and sustainable marine-based livelihoods

Deliverable 3 – Marine Pollution Management Methods and Tools Review Report

Control:

Initial Version:

Date	Author	Responsible for the review	Responsible for verification and approval
02/05/2023	NEMUS, Lda	AC/PB	PB

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Acronyms

ACTO: Amazon Cooperation Treaty Organization, 105
CARICOM: Caribbean Community, 105
CCOA: Commonwealth Clean Ocean Alliance, 135
Cefas: Centre of Environment, Fisheries and Aquaculture Science, 135
CEMP: Coordinated Environmental Monitoring Programme, 92
CFU: Colony-Forming Unit, 78
Chl-a: Chlorophyll a, 117
CLiP: Commonwealth Litter Programme, 135
CLME+: Caribbean Large Marine Ecosystem, 112
CZMU: Coastal Zone Management Unit, 192; Coastal Zone Management Unitt, 192
DIN: Dissolved Inorganic Nitrogen, 117
DIP: Dissolved Inorganic Phosphorus, 117
DO: Dissolved Oxygen, 117
EBM: Ecosystem Based Management, 15
EPD: Environmental Protection Department, 182
FAO: Food and Agriculture Organization, 107
FIO: Faecal Indicator Organism, 73
GEF: Global Environment Fund, 103
GNC: Global Nutrient Management Toolbox, 111
GPA: Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, 107
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ICEP: Index of Coastal Eutrophication Potential, 111
IGO: Intergovernmental Organizations, 105
IW: International Waters, 104
MEA: Multilateral Environmental Agreements, 110
MPo: Monitoring Programme, 85
MSFD: Marine Strategy Framework Directive, 80
N: Nitrogen, 110
NGOs: Non-Governmental Organizations, 67
NOAA: National Oceanic and Atmospheric Administration, 37
NUE: Nitrogen Use Efficiency, 112
OECS: Organisation of Eastern Caribbean States, 1
P: Phosphorus, 110
PMe: Program of Measures, 85
RACs: Regional Activity Centre, 107
RAN: Regional Activity Network, 107
RAPMaLi: Regional Action Plan on Marine Litter Management for the Wide Caribbean Region, 96
RNPRSAP: Regional Nutrient Pollution Reduction Strategy and Action Plan, 99
RWSF: Recreational Water Safety Framework, 68
RWSP: Recreational Water Safey Plan, 68
SDG: Sustainable Development Goal, 8
SICA/CCAD: Central American Integration System/Commission for Environment and Development, 105
SIDS: Small Island Developing States, 16
STAC: Scientific and Technical Advisory Committee, 107
UN: United Nations, 103
UNEA: United Nations Environment Assembly, 103
UNEP: United Nations Environment Programme, 105

WCR: Wider Caribbean Region, 99
WHO: World Health Organization, 66
WIO: Western Indian Ocean, 118

1. Introduction

The present document is Deliverable 3 – Marine Pollution Management Methods and Tools Review Report of the ***Development of a Marine Pollution Management Strategy and Action Plan in Barbados to promote the preservation of marine habitats, marine ecosystem services, healthy ocean space and sustainable marine-based***, conducted by NEMUS – Gestão e Requalificação Ambiental, Lda., for the Organisation of Eastern Caribbean States (OECS).

The "Marine Pollution Management Methods and Tools Review Report" has the following structure:

- Chapter 1 - Introduction;
- Chapter 2 - Objectives and approach;
- Chapter 3 - Marine pollution management methods, tools and good practices;
- Chapter 4 - Relevance of methods, tools and good practices;
- Chapter 5 – Feasibility of introducing solutions into national plan-making process;
- Chapter 6 - Recommendations to successfully integrate feasible solutions;
- Chapter 7 - Concluding remarks;
- Chapter 8 - References.

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2. Objectives and approach

2.1. Assignment scope and objectives

The overall objective of the project is to promote the preservation of marine habitats, marine ecosystem services, a healthy ocean space and sustainable marine-based livelihoods in Barbados, through the development of a **Marine Pollution Management Strategy and Action Plan**.

For this purpose, the consultancy includes assessments of Barbados' governance structures for decision-making on development initiatives and will provide targeted recommendations and interventions.

The assignment will target a group of key-stakeholders, comprising governmental bodies, and public, private, and third sector organisations (including Civil Society Organisations), related to the management of coastal resources and ecosystems.

The consultancy is divided into six major tasks, each resulting on a deliverable (Figure 1).

Task 1: Online inception meeting with Project Steering Committee

- Presentation of the methodology and workplan and agreement on procedures for organisation of the work
- Deliverable: **Inception Report**

Task 2: Situational analysis of the national marine planning and management system and process

- Understand the scope, powers and tools available to marine pollution management stakeholders within the legislative and regulatory context; the process by which plans and policies are prepared and implemented; and their results monitored and evaluated.
- Deliverable: **Situational Analysis Report**

Task 3: Review of marine pollution management methods and tools

- Review of selected international tools, methods and good practices, which will indicate how the methods are relevant and include recommendations on how they can be applied within Barbados
- Assess the feasibility of introducing solutions into the national plan-making process, and make recommendations regarding the necessary conditions and requirements to successfully integrate feasible solutions into the process
- Deliverable: **Marine Pollution Management Methods and Tools Review Report**

Task 4: Stakeholder Consultation to review and validate findings

- Structure findings and recommendations from the previous reports in a form appropriate to facilitate feedback from key stakeholders in order to inform the development of the Marine Pollution Management Strategy and Action Plan for Barbados
- Deliverable: **Stakeholder Consultation Report**

Task 5: Development of a Draft Marine Pollution Management Strategy and Action Plan

- Develop the Draft Marine Pollution Management Strategy and Action Plan for review and finalisation
- Deliverable: **Draft Marine Pollution Management Strategy and Action Plan for Barbados and Monitoring and Evaluation and Resource Mobilisation plan**

Task 6: Prepare and submit a Final Consultancy Report

- Prepare and submit a consultancy completion report
- Deliverable: **Final Consultancy Report**

Figure 1 – Key components in which the project is divided

2.2. General approach to the assignment

The general approach to develop the assignment includes the following main tasks:

- 1. Inception Meeting with Project Steering Committee;
- 2. Situational Analysis of the National Marine Planning and Management System and Process;
- 3. Review of Marine Pollution Management Methods and Tools;
- 4. Stakeholder Consultation;
- 5. Draft Marine Pollution Management Strategy and Action Plan;
- 6. Final Consultancy Report.

2.3. Technical Report 2 a) Marine Pollution Management Methods and Tools Review Report objectives

Deliverable 3 - Technical Report 2 a) Marine Pollution Management Methods and Tools Review Report considers the following sub-tasks in the Work Plan for the Assignment (as presented in Inception Report):

- 3.1. Selection and review of international tools, methods and good practices;
- 3.2. Assess relevance of tools, methods and good practices;
- 3.3. Assess feasibility of introducing solutions into the national plan-making;
- 3.4. Make recommendations to successfully integrate feasible solutions into the process.

The objective for the current phase of the consultancy is to identify and recommend international tools, methods and good practices on several aspects (indicators and metrics of impactful economic activities, marine pollution management options, monitoring processes, management results' evaluation, etc.) that may be applicable to Barbados.

Aiming to achieve these objectives, an extensive bibliographic review was conducted on available strategies, directives, guidelines and other sources, applied in other geographic contexts, and was then assessed in light of Barbados' institutional, economic and environmental contexts, analysed in the previous step.

The results from this assessment are subsequently used as the foundation for the development of a first set of solutions for facilitating marine pollution management in Barbados, and recommendations on how to better implement them in the country. A summary of steps under this phase is represented in Figure 2.

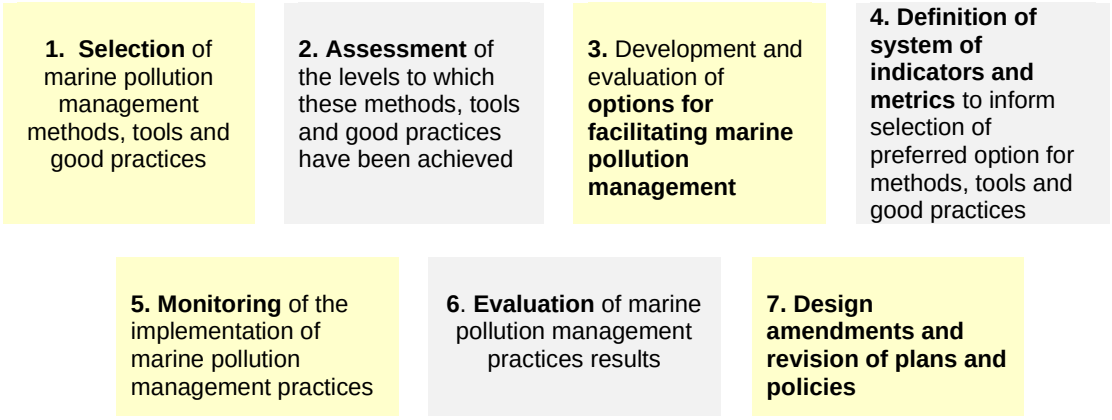

Figure 2 - Steps for the review of methods and tools

3. Marine pollution management methods, tools and good practices

3.1. Contents and overview

This chapter aims to summarise the key information collected through the analysis of existing sources relating to planning and implementation of marine pollution management and will feed a marine pollution management strategy and action plan (sub-task 3.1 in Work Plan for the Assignment).

Work is accomplished in the following steps:

- Selection of marine pollution management methods, tools and good practices;
- Assessment of the levels to which these methods, tools and good practices have been achieved.

3.2. Selection of methods and tools

According with the ToR, intended marine pollution control and management activities and coastal zone management activities to be developed in the present project should be aligned firstly with two main strategic frameworks:

- Sustainable Development Goals (UNDP, 2023), under the United Nations Agenda 2030;
- Regional Strategy for the Protection and Development of the Marine Environment of the Wider Caribbean Region (UNEP/CEP, 2021a), under the Caribbean Environment Programme.

Concerning the **Sustainable Development Goals (SDGs)** (UNDP, 2023), actions are required to address primarily SDG 14 - Life Below Water, while, given the integration between different goals, other goals are also relevant for marine pollution management (Figure 3). Specific targets related to marine pollution are summarised in Table 1.

Source: (Diez, et al., 2019)

Figure 3 – Marine pollution management and relevant SDG

Table 1 – SDG and specific targets related to marine pollution management

SDG	Targets
• **SDG 1 – No Poverty**	• By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters
• **SDG 2 – Zero Hunger**	• By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment • By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality
• **SDG 3 – Good Health and Well-Being**	• By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases • By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination • Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks
• **SDG 6 – Clean Water and Sanitation**	• By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally • By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity • By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

SDG	Targets
	• By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies • Support and strengthen the participation of local communities in improving water and sanitation management
• **SDG 8 – Decent Work and Economic Growth**	• Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-year framework of programmes on sustainable consumption and production, with developed countries taking the lead • By 2030, devise and implement policies to promote sustainable tourism that creates jobs and promotes local culture and products
• **SDG 9 – Industry, Innovation and Infrastructure**	• By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities
• **SDG 11 – Sustainable Cities and Communities**	• By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries • By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management
• **SDG 12 – Responsible Consumption and Production**	• By 2030, achieve the sustainable management and efficient use of natural resources • By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment • By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse

SDG	Targets
• **SDG 13 – Climate Action**	• Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries • Integrate climate change measures into national policies, strategies and planning • Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and small island developing States, including focusing on women, youth and local and marginalized communities
• **SDG 14 – Life Below Water**	• By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution • By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans • Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels • Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources
• **SDG 15 – Life on Land**	• By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally • By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world

Source: adapted from (UNDP, 2023)

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Focusing on SDG 14, which aims to sustainably manage and protect marine and coastal ecosystems from pollution, as well as address the impacts of ocean acidification, actions required to address governance of marine pollution must consider (Lloyd-Smith & Immig, 2018):

- International conventions and programs concerning chemicals and wastes and a new international instrument for plastics;
- Review of water quality standards, for harmonization of global standards for marine water;
- Biomonitoring programs;
- Expanding and implementing extended producer responsibility programs;
- Zero waste policies;
- Pollution prevention while avoiding regrettable substitution;
- Remediation and clean-up;
- Fishing and ocean certification systems;
- Community awareness-raising, capacity building and empowerment.

The **Draft Regional Strategy for the Protection and Development of the Marine Environment of the Wider Caribbean Region** (UNEP/CEP, 2021a), endorses the following vision and mission:

- Vision: Healthy, resilient and biologically diverse coastal and marine ecosystems of the Wider Caribbean Region provide a secure supply of ecosystem goods and services for human well-being and livelihoods and contribute to sustainable development/SDGs for the benefit of present and future generations;
- Mission: To facilitate integrated ecosystem-based management through the control, reduction and prevention of marine pollution and the conservation, sustainable use and restoration of coastal and marine resources and habitats.

The Strategy aims the achievement of the strategic objectives and work programmes/governance framework as presented in Table 2. The Pollution Work Programme is further detailed in Table 3.

Table 2 – Draft Regional Strategy for the Protection and Development of the Marine Environment of the Wider Caribbean Region strategic objectives and associated work programmes

Strategic objective	Action
• **Marine Biodiversity Conservation and Management**: support policies, strategies and action plans that enable the integrated ecosystem-based management and sustainable use of coastal and marine resources	**Marine Biodiversity Work Programme** – Towards healthy ecosystems and enhanced biodiversity in the Wider Caribbean Region
• **Pollution Prevention, Reduction and Control**: support the integration of innovative pollution prevention and reduction tools, innovative/appropriate technologies including circular economy approaches, waste as a resource and sustainable consumption and production	**Pollution Work Programme** – Towards a pollution and litter free Wider Caribbean Region
• **Knowledge Management, Coordination and Communications**: support knowledge-base to enhance regional and national policy-making through the Cartagena Convention framework for the sustainable management of coastal and marine resources of the Wider Caribbean Region • **Ocean-Based Economies Governance and Circularity**: implement innovative institutional, policy, legislative and sustainable governance frameworks, financing programmes, projects, instruments and initiatives to facilitate the effective implementation of the Convention, its Protocols, Strategies and Action Plans to contribute towards the sustainable development of the Wide Caribbean Region and a transition to sustainable ocean-based economies	**Horizontal Programmes / Governance**

Source: adapted from (UNEP/CEP, 2021a)

Table 3 – Main aspects of the Pollution Work Programme

Aspect	Description
Goal	• Prevent, reduce and control pollution of the coastal and marine environment from land and marine-based sources, enabling meeting of obligations under the LBS Protocol and Oil Spills Protocol
Priority pollution issues	• Marine litter and microplastics • Wastewater management • Reduction of nutrients pollution from non-point sources including poor agricultural practices • Ocean acidification

Themes / Outcomes	• Land and Marine Based Sources of Pollution:
	  • Pollution related policies, legislation and/or regulations updated and/or developed
	  • New and/or updated guidelines on marine pollution
	  • National Plans of Actions developed to address marine pollution, wastewater, marine litter and nutrients
	  • National/Pilot Projects focusing on pollution reduction activities
	  • Training and capacity-building workshops
	• Monitoring and Integrated Ecosystem Assessment:
	  • National recreational water quality monitoring programmes
	  • System for classification of recreational waters for efluent discharges
	  • Training and capacity-building workshops
	• Ecosystem Based Management (EBM) Approaches:
	  • Countries implementing EBM projects
	  • Case studies and/or experience nodes on EBM
	  • Countries supported with decision support tools
	  • Courses/Webinars on EBM or related integrated planning tools
	• Knowledge Management and Communications:
	  • New reports, videos, fact sheets and publications
	  • Press releases and news stories
	  • Promotional events
	  • Decision support tools on pollution developed and/or piloted

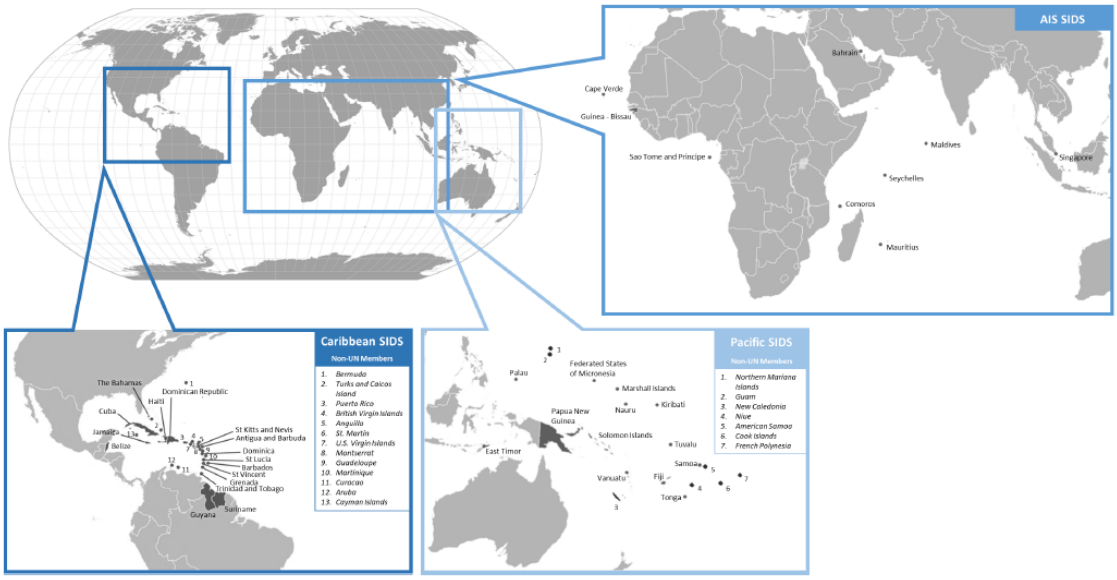
Source: adapted from (UNEP/CEP, 2021a)

Step 2 of the consultancy included a preliminary selection and analysis of different monitoring and evaluation criteria applied in good-practice case studies of marine pollution management, including:

- EU Marine Strategy Framework Directive;
- OSPAR Coordinated Environmental Monitoring Programme.

At this stage this selection is complemented with the survey of other relevant sources for tools, methods and good practices for marine pollution management, collected from:

- Additional sources indicated in the inception phase;
- Further bibliographic research of considered good approaches in marine pollution management worldwide and in the context of the Wide Caribbean region and other tropical Small Island Developing States (SIDS) regions (Figure 4).



Source: (Zitoun, Sander, Masque, Pijuan, & Swarzenski, 2020)

Figure 4 – Geographical regions of Small Island Developing States (SIDS)

Table 4, Figure 5 and Figure 6 show an overview of the selected methodological frameworks. These include both general and regional/national (Figure 7) methods, tools and practices on marine pollution management.

Table 4 – Marine pollution management methods, tools and practices

Method, tool or practice	Reference
General	
UN Technical Guidelines for pollution (UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter)	(UNEP/IOC, 2009)
NOAA Guidelines for the Monitoring and Assessment of Plastic Litter in the Ocean	(GESAMP, 2019)
Marine Pollution Control Legal and Managerial Frameworks	(Christodoulou-Varotsi, 2018)
WHO Guidelines for safe recreational water environments	(WHO, 2021)
Regional/ National	
Marine Strategies for Portuguese Marine Waters / Madeira Islands	(Governo de Portugal, 2014)
OSPAR Coordinated Environmental Monitoring Programme	(OSPAR Commission, 2016) (OSPAR Commission, 2021)
Regional Action Plan on Marine Litter Management (RAPMaLi) for the Wider Caribbean Region 2014	(UNEP/CEP, 2014)
Regional Nutrient Pollution Reduction Strategy and Action Plan for the Wider Caribbean Region	(UNEP/CEP, 2021)
National Marine Litter Action Plan for Belize	(Department of the Environment, 2019)
Western Indian Ocean Strategic Framework for Coastal and Marine Water Quality Management	(UNEP/Nairobi Convention Secretariat; CSIR, 2021a)
Australian and New Zealand Guidelines for Fresh and Marine Water Quality	(Commonwealth of Australia, 2018)
Cleaner Pacific 2025 Strategy and Implementation Plan	(SPREP, 2016) (SPREP, 2022)

Figure 5 – General marine pollution management methods, tools and practices

Figure 6 – Regional/national marine pollution management methods, tools and practices

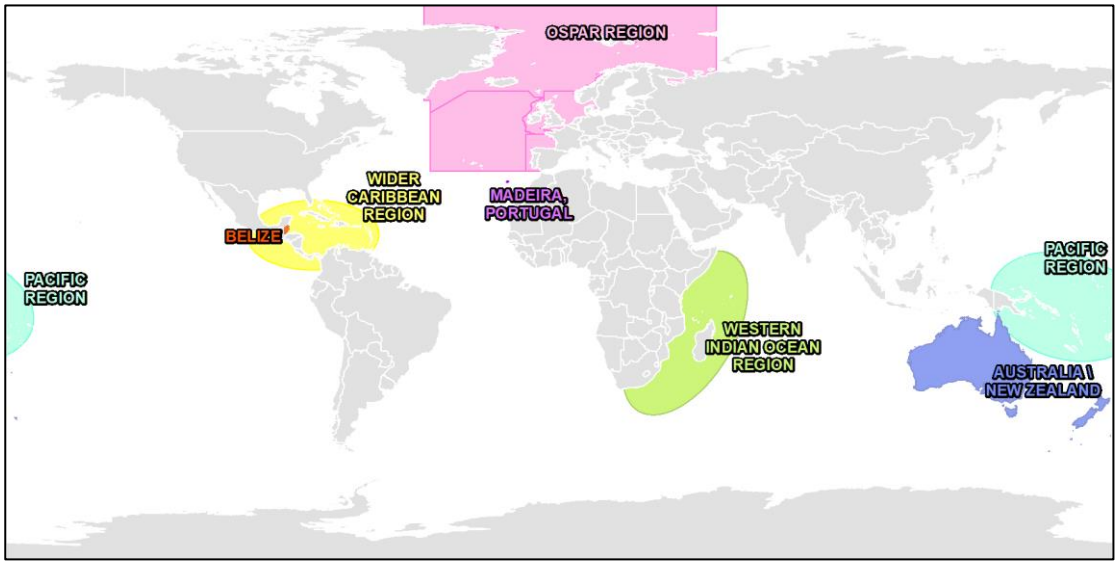


Figure 7 – Overview of location of regional/national marine pollution management methods, tools and practices selected: Wider Caribbean Region, OSPAR Region, Western Indian Ocean, Pacific Region, Madeira Islands (Portugal), Belize, Australia & New Zealand

Section 3.3 present descriptions of the selected documents, aiming at identifying key elements which can later feed the formulation of a marine pollution management strategy and action plan in Barbados. Table 5 below presents comparative overviews of the documents aiming to highlight key elements for future consideration, including:

- Key elements of marine pollution management;
- Pollution issues;
- Account of pollution sources;
- Selection of management options;
- Evaluation of management:
  - Monitoring;
  - Evaluation of results;
  - Revision of plans and policies.

Table 5 – Guidelines for Marine Pollution Management methods, tools and practices

General:

1 - UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter; **2** - NOAA Marine Debris Program; **3** - Marine Pollution Control Legal and Managerial Frameworks; **4** - WHO Guidelines for safe recreational water environments

Regional/National:

5 - Marine Strategies for Portuguese Marine Waters / Madeira Islands; **6** - OSPAR Coordinated Environmental Monitoring Programme; **7** - Regional Action Plan on Marine Litter Management (RAPMaLi) for the Wider Caribbean Region 2014; **8** - Regional Nutrient Pollution Reduction Strategy and Action Plan for the Wider Caribbean Region; **9** - Western Indian Ocean Strategic Framework for Coastal and Marine Water Quality Management; **10** - National Marine Litter Action Plan for Belize; **11** - Australian and New Zealand Guidelines for Fresh and Marine Water Quality; **12** – Cleaner Pacific 2025 Strategy and Implementation Plan

Issues from guidelines	Guidelines											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Key elements												
Vision and Mission						√		√		√	√	√
Guiding Principles	√	√		√		√		√	√	√	√	√
Strategic Goals	√	√		√				√	√	√	√	√
Performance Indicators and Targets				√	√	√		√	√	√	√	√
Strategic Actions							√	√		√	√	√
Action Plan							√	√	√	√	√	√
2. Pollution issues												
Litter and microplastics	√	√	√		√	√	√		√	√		√
Wastewater			√	√	√	√			√			√
Nutrients					√	√		√	√			√
Acidification			√		√	√			√			
Oil			√						√			√
Hazardous substances			√	√	√	√			√			√
Suspended sediments									√			
3. Account of pollution sources												
Land-based	√	√		√	√	√	√	√	√	√	√	√
Urban				√	√	√	√	√	√	√		√
Agriculture				√	√	√	√	√	√			√
Industry				√	√	√	√	√	√			√
Tourism				√	√	√	√	√	√	√		√

General:

1 - UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter; **2** - NOAA Marine Debris Program; **3** - Marine Pollution Control Legal and Managerial Frameworks; **4** - WHO Guidelines for safe recreational water environments

Regional/National:

5 - Marine Strategies for Portuguese Marine Waters / Madeira Islands; **6** - OSPAR Coordinated Environmental Monitoring Programme; **7** - Regional Action Plan on Marine Litter Management (RAPMaLi) for the Wider Caribbean Region 2014; **8** - Regional Nutrient Pollution Reduction Strategy and Action Plan for the Wider Caribbean Region; **9** - Western Indian Ocean Strategic Framework for Coastal and Marine Water Quality Management; **10** - National Marine Litter Action Plan for Belize; **11** - Australian and New Zealand Guidelines for Fresh and Marine Water Quality; **12** – Cleaner Pacific 2025 Strategy and Implementation Plan

Issues from guidelines	**Guidelines**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Marine-based	√	√	√	√	√	√	√	√	√	√	√	√
4. Pollution sources management												
Regulations			√	√	√		√	√	√	√		√
Best practices			√	√			√	√	√	√	√	√
Surveys	√	√	√	√	√	√	√	√	√	√	√	√
Certification			√		√		√			√		
Incentives								√	√	√	√	
Resource planning			√				√		√	√		√
Contingency planning			√	√			√	√	√			√
5. Selection of management options												
Other plans					√			√	√			√
Risk analysis			√							√	√	
Cost/ benefit assessment			√		√		√	√			√	
Stakeholders consultation			√				√	√	√	√	√	√
Research	√	√		√			√	√		√	√	√
Priority setting / Hotspots							√	√	√	√	√	
6. Evaluation of management												
Monitoring and evaluation			√		√	√	√	√	√	√	√	√
Revision of plans and policies			√					√	√		√	√

3.3. Review of methods and tools

According with the Terms of Reference, selected methods and tools are reviewed focusing guidance on the following issues:

- Measurement, quantification and management of the contributions of the various economic activities to marine pollution, using indicators and metrics;
- Evaluation of different options for marine pollution management, using indicators and metrics to inform the selection of preferred options;
- Monitoring of marine pollution management strategies, evaluating results and designing amendments and revision of plans and policies.

3.3.1. UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter

One of the major obstacles to addressing the global problem of marine litter, as identified by the United Nations General Assembly Resolution (A/60L.22), is the lack of data that can be used to identify the sources, movement and pathways, oceanographic dynamics, trends and overall status of marine litter.

To address this issue, UNEP's Regional Seas Programme (RSP), UNESCO's IOC and the Australian Government have worked together through the Global Initiative on Marine Litter to develop guidelines to "standardise" and "harmonise" the survey and monitoring of marine debris around the world, in particular:

- Collect information from around the world on existing experience and methods for the monitoring and assessment of marine litter drawing on information already compiled by UNEP, OSPAR, HELCOM, the Australian Department of the Environment and Water Resources, the Ocean Conservancy's NMDMP and other relevant sources;
- Develop a comparative analysis of selected methodologies for marine litter survey and monitoring, including reporting protocols and forms;
- Develop a set of practical operational guidelines on survey and monitoring of on-shore, floating and sea-floor marine litter for consistent application worldwide. These guidelines include advice on the format and organization of data needed to support statistical and trend-based analyses.

An international Technical Working Group (TWG) of sixteen 'globally distributed' experts from different regions and countries around the world was established to undertake a detailed review of 13 different sampling protocols currently used around the world to survey beach litter, benthic and/or floating marine debris. 46 criteria were used to **evaluate the sampling protocols**, including the basic design of the survey, the analysis of sample units, the frequency and timing of surveys, the methods used to classify litter and the supporting framework for facilitating and managing logistics.

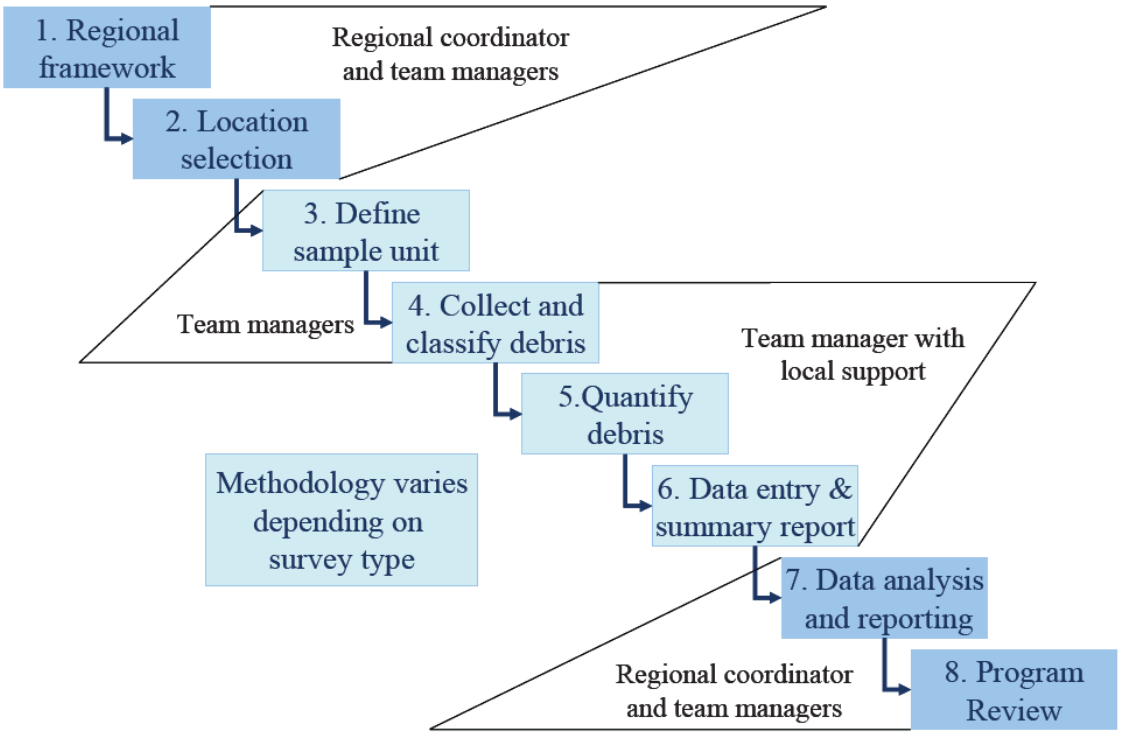
The protocols for survey design, guidance and data collection are designed to enable both in-depth surveys and monitoring, as well as rapid surveys that can be used by community-based or other non-research trained people. These protocols for the assessment of beach, benthic and floating debris have been developed from a number of existing survey protocols that have been used successfully in different regions of the world, which together provide:

- Proven frameworks for delivery of long term, large scale marine litter surveys using trained (although often voluntary) survey participants;
- Frameworks that support the development of litter summaries at a variety of spatial and temporal scales;
- Methodologies that collectively satisfy most of criteria concerning survey framework, sampling units and sampling frequency, litter characterization, logistics and capability;
- Methodologies that are rigorous but still flexible enough to encompass a range of different litter management objectives;
- Methodologies that have the capacity to address quality assurance and quality control issues.

Litter surveys must be prepared in such a way that they are carried out in accordance with established guidelines and fit into and within the context of a larger regional management framework. To ensure consistency between areas and to facilitate national, regional and global analysis of litter data, three aspects of this framework need to be established. These are:

- Effective and culturally appropriate systems for the recruitment and training of field staff and / or volunteers.
- Establishment of a system for selecting litter survey sites at national and regional levels; and

- Standardisation of the system used to classify and quantify litter (to support comparisons over broad regional and global scales).



Source: (UNEP/IOC, 2009)

Figure 8 – Steps in developing a marine litter assessment

This document therefore provides a set of standardized operational guidelines for the conduct of beach, benthic and floating debris assessments, which will enable the estimation and interpretation of debris levels on beaches and within seas and oceans through long-term, large-scale comparative studies, to support management at both national and international levels.

Marine litter is defined as any discarded or lost material resulting from human activities that has entered the marine environment. This includes any material found on beaches, floating or sunk at sea. Organic materials are only included if they have undergone some form of processing (e.g., cloth and processed wood) and therefore exclude naturally occurring materials such as vegetation.

The review resulted in an agreed set of operational guidelines to support the implementation of marine litter surveys. A total of **four sets of guidelines** have been produced, one for each of the following areas:

- Comprehensive assessments of beach cast litter (Table 6);
- Assessments of benthic litter (Table 7);
- Assessments of floating litter (Table 8); and
- Rapid assessments of beach cast litter (Table 9).

Table 6 - Operational Guidelines for Comprehensive Beach Litter Assessment

Beach Litter Assessment	Issues/practices
Objectives	• Quantification and characterization of marine litter for the purposes of developing and evaluating the effectiveness of management, control, enforcement and/or mitigation strategies in particular integration with solid waste management. • Understanding the level of threat posed by marine litter to biota and ecosystems. • Providing comparable datasets to support national, regional and global assessments of marine litter.
Selection and characterization	When undertaking beach litter assessments as part of a regional programme there is a need to: • Identify and select suitable beaches to allow the establishment of appropriate sampling units; and • To develop a survey schedule to ensure that data are collected as required over the lifetime of the study. Basic beach selection criteria (*National Marine Debris Monitoring Program*, Ocean Conservancy USA): • A minimum length of 100 m (i.e. sufficient to fit the smallest sampling unit) although beaches with small amounts of litter may need to be longer (e.g. 1 km) Figure 9; • Low to moderate slope (15 – 45º), which precludes very shallow tidal mudflat areas that may be many kilometres wide at low tide; • Clear access to the sea (not blocked by breakwaters or jetties) such that marine litter is not screened by anthropogenic structures; • Accessible to survey teams year round;

Beach Litter Assessment	Issues/practices

	• Ideally the site should not be subject to any other litter collection activities, although it is recognized that in many parts of the world large scale maintenance cleaning is carried out periodically (timing of non-survey related beach cleaning must be known such that the amount of litter accumulation per unit time can be determined);
	• Survey activities should be conducted so as not to impact on any endangered or protected species such as sea turtles, sea birds or shore birds, marine mammals or sensitive beach vegetation;
	• Although the Northwest Pacific Action Plan and OSPAR selection criteria specify that sites should not be within close proximity to rivers, harbours and ports (NOWPAP 2007b, OSPAR 2007) it is recommended that within the above constraints, the location of sampling sites within each zone should be stratified such that samples are obtained from beaches subject to different litter exposures, including:
	  • Urban coasts (i.e., mostly terrestrial inputs);
	  • Rural coasts (i.e., mostly oceanic inputs);
	  • Within close distance to major riverine inputs.
	
	Data from replicates should be aggregated and standardized by total length of beach surveyed, before any analysis that attempts to elucidate regional patterns.

Sampling units	• Sampling units of 100-1000 m (Figure 9) • Sample length is measured along the curve of the beach at the mid-point between the low tide mark and the back of the beach. Each sampling unit represents the entire area along each transect from the water's edge (preferably surveyed at low tide) to the back of the beach • If more than one sampling unit occurs on a beach the minimum separation distance shall be at least 50 m
Sampling frequency	• Minimum sampling frequency for any site should be annually; ideally it is recommended that locations be surveyed every three months
Litter categories and measurement	• All litter, within the sampling unit, that is larger than 2.5 cm in the longest linear dimension should be collected • Litter must be sorted into classes and quantitatively measured

Beach Litter Assessment	Issues/practices
Data sheets	• Three data sheets including: • Site characterization data sheet: used to record information on the depositional nature of the environment and proximity to local litter sources (needs to be filled out only once for each beach location). • Litter characterization data sheet: used to record survey specific data including categorization and measurement of litter (basic datasheet to be filled in for every survey at each site). • Large items data sheet: used to record data on litter items that cannot be removed; needs to be used for all such items to ensure that they are only counted once (i.e. for the survey during which they are first encountered even if this is the initial clearance survey); subsequent surveys should be conducted with reference to previously collected data and ideally a summary of this information should be taken into the field to ensure that these items are not recounted.

Source: (UNEP/IOC, 2009)

Source: (UNEP/IOC, 2009)

Figure 9 – Beach Sampling Unit

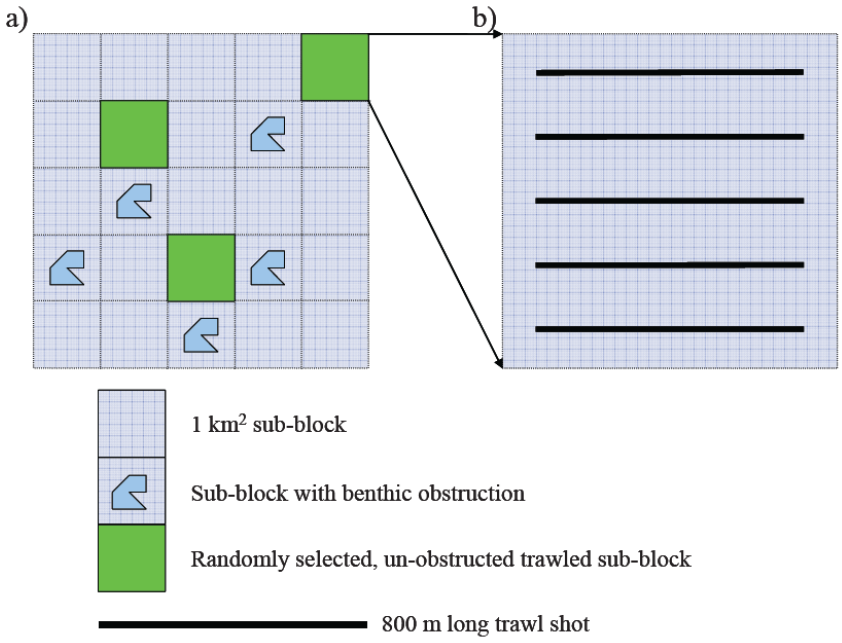
Table 7 - Operational Guidelines for Benthic Litter Assessment

Benthic Litter Assessment	Issues/practices
Objectives	• Quantification and characterization of marine litter for the purposes of developing and evaluating the effectiveness of management, control, enforcement and/or mitigation strategies in particular integration with solid waste management. • Understanding the level of threat posed by marine litter to biota and ecosystems. • Providing comparable datasets to support national, regional and global assessments of marine litter.
Selection and characterization	<u>Trawl survey</u> Sites should be selected to ensure that: • Comprise areas with uniform substrate (ideally sand/silt bottom); • Are of uniform depth; • Focus on areas that are known to generate/accumulate marine litter; • Avoid areas where there is a risk of unexploded munitions • Avoid sensitive and/or pristine habitats that might be damaged by trawling operations; • Are areas that would not impact on any endangered or protected species such as sea turtles, sea/shore birds or marine mammals. <u>Visual survey</u> Sites should be selected to ensure that: • Are at depths of less than 20 m deep for diver safety and bottom time considerations (based on a maximum non-decompression bottom time of ~ 50 minutes at 18 m depth). Beyond this depth remote methods (i.e., camera tows) should be used; • Focus on areas that are known to generate/accumulate marine litter; • Avoid areas of potential hazard to divers (e.g., shipping channels, areas with high currents, or seal breeding areas with associated shark attack risks); • Have ready access, from support vessel or from shore; • Are accessible all year round; if a site is not accessible due to weather or other circumstances then data can be adjusted during analysis. • Will not impact on any endangered or protected species such as sea turtles, sea/shore birds, marine mammals or sensitive beach vegetation. • Have known depositional characteristics and anthropogenic influences.

Benthic Litter Assessment	Issues/practices
	Within the above constraints on site selection, sampling units for both methods should be stratified relative to sources within a region such that samples are obtained from: • Urban coasts (i.e., mostly terrestrial inputs). • Rural coasts (i.e., mostly oceanic inputs). • Within close distance to major riverine inputs. • Offshore areas (major currents, shipping lanes, fisheries areas, etc.).
Sampling units	Trawl survey • A sampling unit will comprise a fixed 5 km × 5 km survey area. The benthos in this area should be pre-surveyed using either side scan sonar or direct camera observations. This pre-survey will help determine the nature of the trawl gear to be deployed (e.g., nets or grapples) and should also be used to identify areas that need to be avoided (e.g., where benthic obstructions could impact on trawl operations). In setting up the pre-survey the area should be sub-divided into twenty-five 1 km × 1 km sub-blocks which will be individually assessed for trawl suitability (Figure 10). Visual survey • 100 m (or longer) belt transect that is run at a fixed depth parallel to shore. (Figure 11)
Sampling frequency	Trawl survey & Visual survey • Annually. Given that the opportunity exists for some benthic litter surveys to be conducted in close geographical proximity to beach survey sites, then the survey may be conducted at the same time as one of the beach surveys
Litter categories and measurement	Trawl survey • Trawled litter classified using standard categories and quantified using weights or number of items as appropriate. Visual survey • All litter classified using standard list. Litter items should be counted unless the material is being collected in which case counts and weights may be obtained
Data sheets	Trawl survey & Visual sruvey Three data sheets have been developed: • Site characterization data sheet: used to record information about the general area of the 5 km by 5 km survey location, records information on the nature of the benthic habitat and the proximity to likely litter sources; should be filled out only once for each location.

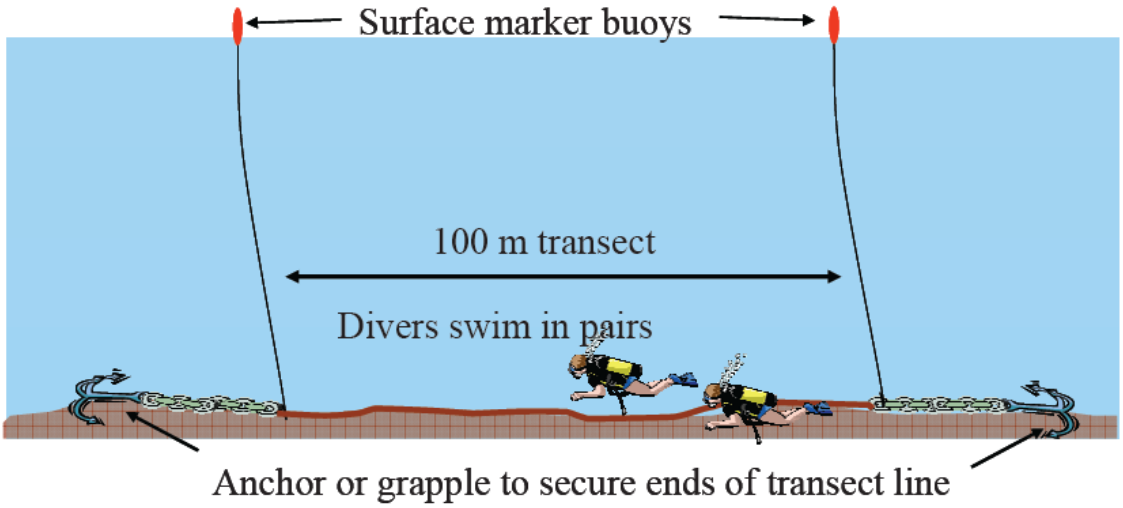
Benthic Litter Assessment	Issues/practices
	• Trawl litter data sheet[1]: used to record survey specific data including categorization and measurement of litter; the basic datasheet to be filled in for every trawl shot at each site; multiple trawl shots are run at any given site, then a new sheet should be used for each shot. • Litter characterization data sheet[2]: used to record survey specific data including categorization and measurement of litter, the basic datasheet to be filled in for every survey at each site; if multiple transects are run at any given site, then a new sheet should be used for each transect. • Large items data sheet: used to record data on litter items that cannot be removed; this sheet needs to be used for all items to ensure that such items are only counted once (i.e., for the survey during which they are first encountered); before undertaking a re –survey of any site this information should be reviewed to ensure that the location of such items is known

Notes: 1-Data sheet only applicable for Trawl survey; 2 – Data sheet applicable for Visual survey
Source: (UNEP/IOC, 2009)



Source: (UNEP/IOC, 2009)

Figure 10 – Layout of benthic trawl samples comprising 3 randomly chosen 1 km × 1km subblocks from a 5 km × 5 km sampling unit; a) the pre-survey identifies 20 sub-blocks that are suitable for trawling operations from which 3 random sub-blocks are selected for trawling; b) 1 km × 1 km sub-block showing location of 5 trawl shots.



Source: (UNEP/IOC, 2009)

Figure 11 – Layout for benthic visual litter survey; divers swim down the transect line and collect or record all litter items found within 2 m on both sides of the line. Litter is then recorded in terms of either the count of items or the weight per unit of length.

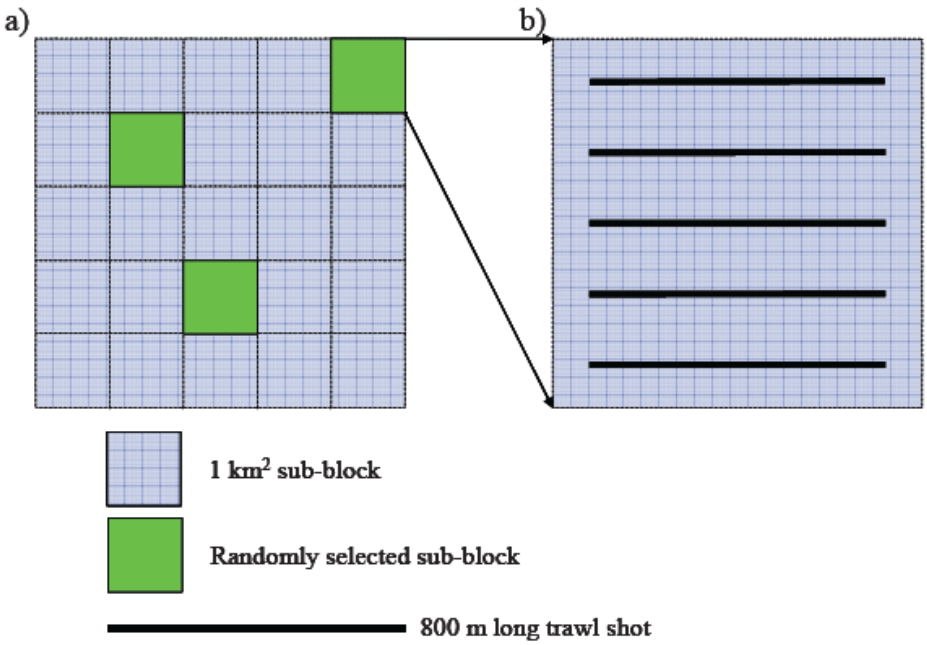
Table 8 - Operational Guidelines for Floating Litter Assessment

Floating Litter Assessment	Issues/practices
Objectives	• Quantification and characterization of marine litter for the purposes of developing and evaluating the effectiveness of management, control, enforcement and/or mitigation strategies in particular integration with solid waste management. • Understanding the level of threat posed by marine litter to biota and ecosystems. • Providing comparable datasets to support national, regional and global assessments of marine litter.
Selection and characterization	<u>Trawl survey</u> Sites should be selected to ensure that: • Focus on areas that are known to generate/accumulate marine litter; • There is no incidental impact on any endangered or protected species such as sea turtles, sea/shore birds or marine mammals. <u>Visual survey</u> Sites should be selected to ensure that: • Focus on areas that are known to generate or accumulate (convergence zones) marine litter such as major shipping lanes, or areas with concentrated fisheries or similar commercial activities.

Floating Litter Assessment	Issues/practices
	• Will not impact on endangered or protected species such as sea turtles, sea/shore birds or marine mammals; although given that visual surveys are generally low impact, relative to benthic or surface trawls, there is generally less scope for impacts. Within the above constraints on site selection, sampling units for both methods should be stratified relative to sources within a region such that samples are obtained from: • Urban coasts (i.e., mostly terrestrial inputs). • Rural coasts (i.e., mostly oceanic inputs). • Within close distance to major riverine inputs. • Offshore areas (major currents, shipping lanes, fisheries areas, etc.).
Sampling units	<u>Trawl survey</u> • Sampling unit comprise a fixed 5 km × 5 km survey area (Figure 12). This area should be divided into twenty-five sub-blocks of 1 km × 1 km. To ensure an unbiased sample a group of 3 sub-blocks should be randomly selected for trawling. <u>Visual survey</u> • Visual Transects should be established by monitoring the time employed by observers rather than attempting to identify fixed length units
Sampling frequency	<u>Trawl survey & Visual survey</u> • Floating litter surveys should be conducted at least annually
Litter categories and measurement	<u>Trawl survey</u> • Trawled litter should be classified using standard categories and quantified using weights or number of items as appropriate. <u>Visual survey</u> • Litter categorization is generally much more difficult for remote observations, simplified list of items has been developed

Floating Litter Assessment	Issues/practices
Data sheets	Trawl survey Three data sheets have been developed: • Site characterization data sheet: used to record information about the general area of the 5 km × 5 km survey location, records information on the nature of the benthic habitat and the proximity to likely litter sources (should be filled out only once for each location). • Trawl litter data sheet: used to record survey specific data including categorization and measurement of litter collected in the trawl; is the basic datasheet to be filled in for every trawl shot at each site; if multiple trawl shots are run at any given site, then a new sheet should be used for each shot. • Large items data sheet: used to record data on litter items that cannot be removed; needs to be used for all items; for floating litter surveys, this would include items such as shipping containers that are too large to bring onboard. Unlike for beach or benthic litter surveys where large items are likely to be fixed in position, it is unlikely that the same item will be encountered on a repeat survey because floating items are highly mobile. Visual survey Two data sheets have been developed: • Site characterization data sheet: used to record information about the survey location, records information about the proximity of the site to likely litter sources (should be filled out only once for each survey). • Visual observation data sheet: used to record survey specific data including categorization and measurement of litter observed, the basic datasheet to be filled in for every transect at each site; if multiple transects are run at any given site then a new sheet should be used for each shot; if multiple observers are recording data with different fields of view (e.g. one person observing to the starboard side and the other person observing to port) then each person should fill out a separate copy of this sheet; data should be aggregated for analysis and reporting.

Source: (UNEP/IOC, 2009)



Source: (UNEP/IOC, 2009)

Figure 12 – Layout of a) floating trawl samples comprising 3 randomly chosen 1 km × 1km sub-blocks from a 5 km × 5 km sampling unit; b) 1 km × 1 km sub-block showing location of 5 trawl shots.

Table 9 - Operational Guidelines for Rapid Beach Litter Assessment

Rapid Beach Litter Assessment	Issues/practices
Objectives	• Quantification and characterization of marine litter for the purposes of developing and evaluating the effectiveness of management, control, enforcement and/or mitigation strategies in particular integration with solid waste management. • Understanding the level of threat posed by marine litter to biota and ecosystems. • Providing comparable datasets to support national, regional and global assessments of marine litter. • Creation and strengthening of public awareness of marine litter issues through community engagement.

Rapid Beach Litter Assessment	Issues/practices
Selection and characterization	Beach selection criteria: • A minimum length of 100 m (i.e. sufficient to fit the smallest sampling unit) although beaches with small amounts of litter may need to be longer (e.g. 1 km); • Low to moderate slope (15 – 45º), which precludes very shallow tidal mudflat areas that may be many kilometres wide at low tide; • Clear access to the sea (not blocked by breakwaters or jetties) such that marine litter is not screened by anthropogenic structures; • Accessible to survey team members all year round; • Survey activities should not be undertaken where there is risk of impact on any endangered or protected species such as sea turtles, sea birds or shore birds, marine mammals or sensitive beach vegetation; in many cases this would exclude national parks but this may vary depending on local management arrangements.
Sampling units	• Rapid litter assessments can be conducted over any length of beach although a minimum survey length of 100 m is recommended than attempting to identify fixed length units. • Length of beach surveyed and the width of the beach should be recorded such that litter quantities can be standardized to kilograms or counts of items per unit length of beach.
Sampling frequency	• Minimum sampling frequency for any one site should be at least annually; ideally sampling should be conducted once every three months to obtain a good comparison of seasonal changes.
Litter categories and measurement	• All litter, within the sampling unit, that is larger than 2.5 cm in the longest linear dimension should be collected • The litter must be sorted into classes and quantitatively measured
Data sheets	Three data sheets have been developed: • Site characterization data sheet: used to record information on the characteristics of the beach and proximity to local litter sources (only needs to be filled out once for each beach). • Litter characterization data sheet: used to record survey specific data including categorization and measurement of litter, the basic datasheet to be filled in for every survey at each site. • Large items data sheet: used to record data on litter items that cannot be removed, needs to be used for all such items to ensure that they are only counted once (i.e., for the survey during which they are first encountered even if this is the initial clearance survey); subsequent surveys should be based on a review of previously collected data and

Rapid Beach Litter Assessment	Issues/practices
	ideally a summary of this information should be taken into the field to ensure that these items are not recounted

Source: (UNEP/IOC, 2009)

3.3.2. NOAA Marine Debris Program: Guidelines for the Monitoring and Assessment of Plastic Litter in the Ocean

NOAA's is an American State Department whose presence is in eight geographic regions is represented by Regional Collaboration Teams, made up of members who represent the interests and capabilities of line office missions. One of these is the Southeast and Caribbean region, where NOAA's Southeast and Caribbean Regional Collaboration Team (SECART) established a forum in the Caribbean in 2011 to increase communication and coordination between NOAA and its partners operating in the Caribbean.

The NOAA Caribbean Strategy (NOAA, 2013) recognizes the same geographic scope as the Caribbean Large Marine Ecosystem, which includes U.S. and non-U.S. jurisdictions (Figure 13). Although Puerto Rico and the U.S. Virgin Islands receive most of the focus, NOAA in the Caribbean seeks to maintain an exchange of resources with Florida and, where appropriate and feasible, with partners in the larger Caribbean.

Source: (NOAA, 2013)

Figure 13 – Geographic scope of the NOAA Caribbean Strategy

The NOAA Marine Debris Program: Guidelines for the Monitoring and Assessment of Plastic Litter in the Ocean (GESAMP, 2019) is a product of the GESAMP Working Group (WG40) on 'Sources, fate and effects of plastics and microplastics in the marine environment', co-led by the Intergovernmental Commission on Oceanography (IOC-UNESCO) and the United Nations Environment Programme (UNEP).

The main objective of this report is to provide suggestions, advice and helpful tips for setting up **programmes to track and measure the distribution and quantity of plastic waste** by promoting a more harmonised approach to the design of sampling programmes, the selection of appropriate indicators (i.e., type of sample), the collection of samples or observations, the characterisation of the sampled material, the management of uncertainties, the analysis of data and the reporting of results.

This publication is intended to help guide the development of regional and national field monitoring programmes. Therefore, national, intergovernmental and international organizations responsible for regulating the social, economic and environmental impacts of land- and sea-based human activities on the marine environment are the primary target audience of the report. It provides links to data collection forms and standards that can be used in the field. The monitoring of plastic waste in the marine environment is the sole scope of this report.

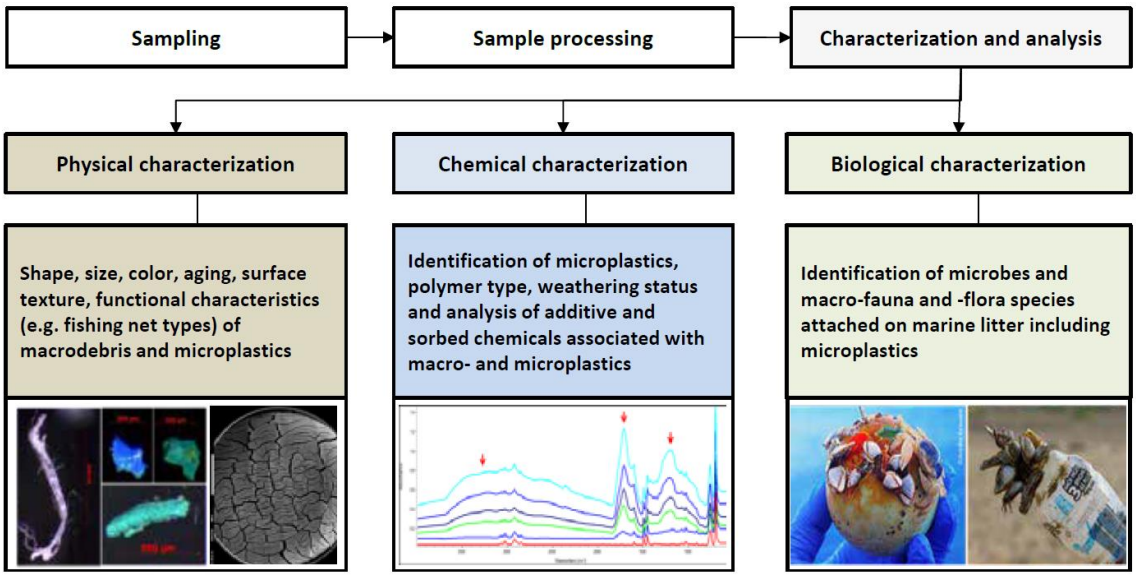
All size ranges of plastic debris found in the marine environment, on shorelines, floating on the sea surface, suspended in the water column, deposited on the seabed or associated with biota (ingested/encrusted/entangled) are covered by the guidelines. The definitions for the **four main size categories** (mega, macro, meso, micro) are summarised in Figure 14, which also provides additional commonly used alternatives for the commonly used size range, particularly for litter in the micro and meso categories. GESAMP recommends that < 5mm should be used as the upper size limit for microplastics for routine monitoring purposes.

Size	Recommended	Alternatives options for operational monitoring and research purposes	
≈		Alternative 1	Alternative 2
Mega	**R** > 1m		
Macro	**R** 25mm – 1m		
Meso	**R** 5-25mm	**F** 1-25mm	**F** 1-5mm and 5-25mm
Micro	**R** <5mm	**F** <1mm	**F** <1mm

Source: (GESAMP, 2019)

Figure 14 - Recommended size categories for routine marine litter monitoring (R = recommended F = feasible/ acceptable)

A step-by-step process for the planning and implementation of a program to monitor plastic litter in the marine environment is provided in the study. It shows how to develop monitoring strategies for the **four main environmental compartments** - shoreline, sea surface/water column, seabed and biota - starting with sample collection and processing (including specific protocols and metadata requirements) and ending with item characterization and data reporting (Figure 15).



Source: (GESAMP, 2019)

Figure 15 - Flowchart of marine litter monitoring

Monitoring and assessment are critical steps in addressing the specific problems associated with marine litter, particularly microplastics. In order to develop mitigation measures, evaluate their effectiveness and support adaptive management, it is necessary to analyze the status or level of pollution and provide objective information. An understanding of the underlying policy issues is essential, as it will have an impact on the nature and scope of the monitoring strategy (Figure 16).

Box 3.1: Examples of policy concerns:

- ❑ Abundance of marine litter in seas under national jurisdiction
- ❑ Type and origin of marine litter
- ❑ Identification of hotspots
- ❑ Setting targets for reduction measures
- ❑ Impacts on:
  - biodiversity and animal welfare
  - human health issues and injuries
  - seafood safety
  - food security – ghost fishing
  - tourism and recreation
  - maritime safety (navigation)

Source: (GESAMP, 2019)

Figure 16 – Examples of policies issues.

As monitoring is goal-directed, the **design of a sampling programme** must take into account the management objectives (e.g. compliance, effectiveness of reduction measures), and the resources available to carry them out, and the sampling strategies, protocols and indicators used must be tailored to the specific questions being asked. These may include risks to human health, compliance with national or international environmental regulations, impacts on biodiversity, impacts on the tourism sector and maritime safety.

Indicators such as the amount of debris per unit of measurement (e.g. area, length or number of organisms) are used to define the 'state' of the ecosystem. Environmental indicators should have the following characteristics:

- Scientifically valid;
- Simple to understand by the public and policy makers;
- Sensitive and responsive to change;
- Cost-effective; and
- Policy relevant.

Designing and implementing monitoring programs that are cost effective, make the best use of often limited resources, and increase the likelihood of programme sustainability are vital. The following **strategies** are advised, and a number of elements are crucial:

- Prioritize the monitoring program to address the most significant risks and associated indicators (i.e., scientific, technical, policy/social relevance, data requirements),
- Favor innovative and opportunistic approaches,
- Encourage cooperation (common services; common cruises),
- Build on existing monitoring activities, and finally
- Encourage monitoring by organizations responsible of the environmental effects (industry, municipalities).

Monitoring should be seen as an ongoing, long-term process based on a series of repeated measurements to establish a baseline condition (e.g., number and type of items) and temporal changes in marine debris, and therefore requires a consistent approach in terms of sampling location, processing and characterization of samples.

The design of a monitoring and assessment programme, particularly the choice of **sampling locations**, has a significant impact on the quality and usefulness of the programme. Ensuring that the sites reflect the level of litter in a given region is a critical factor. The following levels of resolution can be defined:

- Spatial resolution
- Temporal resolution
- Sample/ecological resolution

The document then goes on to make a number of recommendations, including selection criteria based on both resource/capacity constraints and based on both resource/capacity constraints and policy issues to be addressed (Figure 17 to Figure 21).

Survey goal	Size	Sandy beaches	Rocky shores	Mangroves and Salt Marshes	Comments
Baseline surveys	Mega	R	F	F	One-off visual surveys
	Macro Surface	R	F[a]	F	One-off visual surveys
	Macro Buried	F			Sieve to collect litter; sample to at least 10 cm deep
	Meso	R			Sieve to collect litter to ≥5-10 cm deep
	Micro	F (cores[b])		F (cores)	Surface sieving or sediment cores
Monitoring	Mega	R	F		Mark litter and resample at regular intervals
	Macro Surface	R	F	F	Remove litter and re-sample
	Macro Buried	F			Accumulation estimates not feasible
	Meso	R			Sampling with 1 m quadrats by sieving > 5 mm
	Micro	R			Dry or wet sieving two or more size categories

Source: (GESAMP, 2019)

Figure 17 – Overview of sampling protocols for different litter size categories per survey goal (baseline survey, monitoring) at three main shoreline types: Sandy Beaches, Rocky Shores (including cobble and boulder beaches) and Mangroves and Salt Marshes (R = recommended, F = feasible; values in parentheses indicate approximate transect widths to sample for different litter size categories)

Compartment	Size	Recommendation	Method	Comments
Water Surface	Mega	F	Aerial survey	Expensive to charter a plane.
	Mega	R	Visual survey	Use ship as the platform to conduct survey.
	Macro	R	Visual survey	See above
	Meso	R	Net tow	Affordable and litter is restricted to surface.
	Micro	R	Net tow	Affordable and litter is restricted to surface.
	Micro	F	Bulk water pump	Costs involved, and training, but will get good microplastic data.
Water Column	Mega	F	Fisheries observer	Cost effective, as you only need to train staff.
	Macro	F	Fisheries observer	Cost effective, as you only need to train staff
	Meso	F	Bulk water pump	Costs involved, and training, but will get good microplastic data.
	Meso	R	Underway sampling	Cost effective. Some equipment involved and training.
	Meso	F	Bongo net	Need vessel with winch, net relatively expensive
	Micro	F	Bulk water pump	Costs involved, and training, but will get good microplastic data.
	Micro	R	Underway sampling	Costs involved, and training, but will get good microplastic data.
	Micro	F	Bongo net	Need vessel with winch, net relatively expensive

Source: (GESAMP, 2019)

Figure 18 – Overview of sampling protocols for different plastic size categories in two compartments (water surface, water column) (R = recommended, F = feasible)

Survey Goal	Water Depth	Size	Soft bottom	Rocky bottoms	Mixed
Initial Assessment					
Diving	Shallow (0-30m)	Mega/Macro	R	R	R
		Meso	F	F	F
		Micro	not visual		not visual
	Deep	any size			
Trawling	Shallow (Net + pole)	Mega/Macro	R		
		Meso	F		
		Micro			
	Deep (<200m), net + pole	Mega/Macro	R		
		Meso	F		
		Micro			
	Ultra deep (<5000m) (pole only)	Mega/Macro	< 5000 m		
		Meso	F		
		Micro	R	R	R
Remote Operated Vehicle (Imagery)	Shallow	Mega/Macro	R	R	R
		Meso	F	R	R
		Micro			
	Deep (shelves/ slopes)	Mega/Macro	R	R	R
		Meso	F	R	R
		Micro			
	Ultra deep	Mega/Macro	R	R	R
		Meso	F	R	R
		Micro			
Core/grab	All depths	Mega/Macro			
		Meso			
		Micro	R		F

Source: (GESAMP, 2019)

Figure 19 – Overview of sampling protocols recommended for initial assessments (diving, trawling, imagery, core/grab) for different plastic size categories by survey method, water depth and type of seafloor (soft or rocky) (R = recommended, F = feasible)

Monitoring					
Diving	Shallow (0-30m)	Mega/Macro	R	R	R
		Meso	F	F	F
		Micro	not visual		not visual
	Deep	Any size			
Trawling	Shallow (Net + pole)	Mega/Macro	OPP		
		Meso			
		Micro			
	Deep (Shelves slope), net + pole	Mega/Macro	OPP		
		Meso			
		Micro			
	Ultra deep (pole)	Mega/Macro	F		
		Meso	F		
		Micro			
Remote Operated Vehicle	Shallow (0-30m)	Mega/Macro	F	F	F
		Meso	F	F	F
		Micro			
	Deep (shelves)	Mega/Macro	OPP	OPP	OPP
		Meso	F	F	F
		Micro			
	Ultra deep	Mega/Macro	OPP	OPP	OPP
		Meso	F	F	F
		Micro			
Core/grab	All depths	Mega/Macro			
		Meso			
		Micro	R		

Source: (GESAMP, 2019)

Figure 20 – Overview of sampling protocols recommended for monitoring surveys (diving, trawling, remote operated vehicle, core/grab) for different plastic size categories by survey method, water depth and type of seafloor (soft-1st column, rocky-2nd column or mixed-3rd column) (R = recommended, F = feasible)

Survey goal	Size	Marine mammals	Birds	Fish	Invert-ebrates	Corals	Epibionts	Remarks
Ingestion	Mega	F						Opportunistic, strandings
	Macro	F	R					OSPAR monitoring
	Meso	F	R					
	Micro	F	R	R	R	F	F	
Entanglement	Mega	R	R			F		Opportunistic strandings
	Macro	R	R			F		
	Meso				F	F		
	Micro							
Habitat	Mega					R	R	
	Macro		R			F	R	
	Meso		F			F	R	
	Micro						R	

Source: (GESAMP, 2019)

Figure 21 – Overview of sampling protocols for different litter size categories in biota per survey goal (ingestion, entanglement, habitat) (R = recommended, F = feasible)

It is usually possible to characterise macro-plastics directly after sampling without the need for an intermediate step. However, depending on the objectives of the monitoring programme, additional processing may be required for micro- and meso-plastics (Figure 22). This may include active techniques such as

- Visual identification to categorise litter items (macro-plastics),
- Filtration/sieving to extract particular size fractions,
- Density separation to extract particles of differing densities, and
- Microscopic identification to establish size, shape and colour (micro- and meso- plastics).

Each of these approaches can be used separately or together, progressing from simpler to more complex (from left to right). It's also possible to change the order of the methods. After sieving or filtering, the particles of the samples are visually sorted, especially those smaller than 1 mm.

Environmental compartment	Size of litter	Hand sorting	Sieving/ filtering	Density separation	Digestion		
					Enzymatic	Alkaline	Oxidative
Shoreline (Chapter 4)	Meso	R	R	R			
	Micro	F	R	R		R	R
Seawater (Chapter 5)	Meso	R	R	R			
	Micro	F	R	R	F	R	R
Sea Floor (Chapter 6)	Meso	R	R	R			
	Micro	F	R	R	F	R	R
Biota (Chapter 7)	Meso	R	R	F	R	R	R
	Micro	F	R	F	R	R	R

Source: (GESAMP, 2019)

Figure 22 – Overview of sampling processing protocols for different environmental compartments and litter size categories (R = recommended, F = feasible)

In terms of plastics characterisation, plastics are a combination of particles with different physical, chemical and biological properties (such as size, shape, polymer and surface properties). A detailed understanding of the properties of plastic particles is required to provide data to support management decisions. This includes the analytical techniques required to characterise the physical (shape, size, colour and functional information), chemical (polymer composition, weathering state and addition of chemicals and sorbed pollutants) and biological (associated biota, etc.) properties of plastics (Figure 23).

Size	Visual observation (naked eye)	Visual observation (microscopy)	Microscopy and spectroscopy (FTIR, Raman)	Alternatives (FTIR-FPA Nano-IR Pyro-GC/MS SEM-EDS)	Comment
Mega	R				
Macro	R				
Meso 5-25 mm	R				Confirmation spectroscopy
Large micro 1-5 mm		R	R	R	Microscopy + spectroscopy
Small micro 0.02-1 mm			R	R	
Very small micro 0.001-0.02 mm			F[a]	R	[a]FTIR/Raman Challenging
Nano < 1 µm				R[b]	[b]Exploratory

Source: (GESAMP, 2019)

Figure 23 – Overview of physico-chemical characterization methods applicable for different litter size categories (R = recommended, F = feasible)

3.3.3. Marine Pollution Control Legal and Managerial Frameworks

The document (Christodoulou-Varotsi, 2018) provides a review of legal and management best practices concerning marine pollution originated by the shipping industry.

Pollution of the marine environment is defined internationally in the United Nations Convention on the Law of the Sea as “the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities”.

Regulations setting can be accomplished in:

- Prescriptive (“command and control”) approach: prohibition to do or refrain from doing certain actions, usually due to risk factors;
- Goal-based approach: standards describe the goals and set out the functional requirements that the rules for the industry shall conform to; in this context, standard-setting can evaluated through risk analysis and cost/benefit assessment;
- Self-regulation: related to a self-assessment approach, whereby private operators are to integrate goals defined by legislation through actions designed and implemented by them after taking into account relevant risks.

The document describe regulatory practices in a set of **leading organisations** operating in marine transport pollution management, comprising:

- IMO: through international conventions, protocols, codes and standards, concerning ship certification and ship conduct, which are enforced by member States;
- European Union: through policies conveying objectives, directly applicable in the legal systems of member States, which are required to be transposed to member States national law by national measures considered fit for the purpose:
    - EU coastal and marine policy, comprising Marine Strategy Framework Directive/Marine Directive (protection of the marine environment and natural resources in an integrated, as opposed to sectoral, approach),

Integrated Maritime Policy/IMP (achieve the full economic potential of the seas in line with the marine environment by taking into account all the sectors affecting the oceans, covering blue growth, marine data and knowledge, maritime spatial planning, integrated maritime surveillance and sea basin strategies), Common Fisheries Policy/CFP (sectoral approach), Water Framework Directive/WFD (inland surface waters, transitional waters, coastal waters and groundwater protection objectives);

- EU maritime transport policy, applicable to EU fleet and to vessels calling at EU ports, which conveys measures that while not addressing environmental issues can benefit the marine environment by preventing marine pollution;

- Non-governmental organisations: including industry best practices and International Organization for Standardisation.

The International Maritime Organization (IMO) is a specialised agency of United Nations considered as the international regulator of shipping, involved in the review of existing conventions due to technological and other developments and with the adoption of new conventions.

IMO's standards concerning marine pollution prevention and management are produced through a process involving member States discussion, deliberation and adoption from a draft made by a technical committee/sub-committee (including the Marine Environment Protection Committee – MEPC). Conventions enter into force provided by specific criteria as being accepted by a specific number of member States.

The organisation is not entrusted with the enforcement of the standards, a responsibility of member States as flag States. Amendments of technical annexes are speeded up through the use of tacit acceptance procedure, through which the amendment enters into force at a particular time unless, before that date, objections to the amendment are received from a specific number of Parties.

IMO standards govern ship certification and therefore the conduct of shipping. Relevant certificates are issued after survey by the flag State or by entities empowered by the flag State for the purpose.

Regulations concerning ship pollution approach marine pollution through the standpoint of flag State, coastal State and port State. Under UNCLOS III flag State jurisdiction

prevails (art. 217), with coastal state following a gradual diminution of powers (referring to State's territorial waters) the further one moves away from the shore (art. 220), and each country determining the conditions for the grant of its nationality to ships.

Classification societies support, as technical supervisory organisations, States in the exercise of their maritime functions, being involved during construction as well as during ship's service life.

The document then progresses to describe regulations and management practices specific to **individual areas of marine pollution**, concerning:

- Oil (petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products;Table 10);
- Sewage (drainage and other wastes from toilets and urinals, drainage from medical premises via wash basins, wash tubs and scuppers, drainage from spaces containing living animals, other waste waters when mixed with drainage referred) and grey water (wastewater from sinks, showers, baths, laundries and galleys) (Table 11);
- Waste (substances or objects disposed of, intendend to be disposed of or required to be disposed of under applicable provisions) and litter (any persistent, manufactured or processed solid material discarded or disposed of or abandoned in the marine and coastal environment) (Table 12);
- Transportation of chemicals (gases, liquids or solids) by sea (Table 13): hazardous and noxious substances/HNS (substances other than oil which, if introduced into the marine environment are likely to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea);
- Air pollution (sulphur oxides and CO_2 emissions; Table 14);
- Other sources (ballast water, anti-fouling, other not within the confines of MARPOL; Table 15).

Table 10 – Legal and management issues and practices concerning oil pollution

Oil pollution	Issues/practices
Source	• Marine pipelines and dry-docked vessels • Coastal facilities (refineries, storage facilities, etc) • Recreational boating • Offshore oil and gas exploration and production • Natural marine seeps
Type of pollution	• Accidental spillage • Slow leakages • Operational discharges: by ship's engines (fuel oil sludge, bilge oils) and tanker's cargoes
Measurement	• Complex estimates on oil inputs at sea (questions on methodology, availability, credibility and treatment of data)
Impacts	• Ecological damage (food chain, marine life, natural resources) • Adverse impact on humans and their activities (economic, tourism, etc.)

Management	• Prescriptive approach of regulations, based on prohibition of all discharges of oil under MARPOL 73/78 Convention Annex I
	• Pollution prevention options for oil transportation regulated include:
	  - Construction requirements: segregated ballast tanks (SBT) (ballast water introduced into a tank completely separated from oil cargo and fuel system and permanently allocated to the carriage of ballast water), double hull (cargo tanks are surrounded with a second internal plate at a sufficient distance from the external layer)
	  - Control of operational discharges of oil from machinery spaces
	  - Control of discharges from the cargo area of oil tankers: including oil discharge monitoring and control system (ODMCS, system which monitors the discharge into the sea of oily ballast or other oil-contaminated water from cargo tank areas) and load on top system (LOT, procedure base on settling and separation of the departure ballast water and the oil, where water layer is allowed to settle and oil should flow to the top in a slop tank)
	  - Crude oil washing (COW): cleaning oil tanks on a tanker with crude oil as washing agent, for reducing marine pollution
	  - Protection of fuel oil tanks
	  - Surveys and certification for oil tankers: including regular surveys and specific procedures such as condition assessment scheme (CAS, survey method aimed at assessing the structural condition of a single hull oil tanker), oil pollution emergency

Oil pollution	Issues/practices
	plans, oil record book, international oil pollution prevention certification • International Safety Management Code (self-regulation) • Ship-to-ship (STS) operations plan • Industry best practices (guidance and other resources)
Implementation	• Reduction of oil split in last decades, due to: • Effectiveness of regulations, including strict sanctions • Modern technologies (e.g. ship construction or oil recovery from casualties) • Environment awareness enhancement, including training • Enhancement of the commitment of companies and personnel • Contribution of stakeholders from oil and shipping industries through various tools, including best industry practices Contribution of non-governmental organisations (NGOs)

Source: adapted from (Christodoulou-Varotsi, 2018)

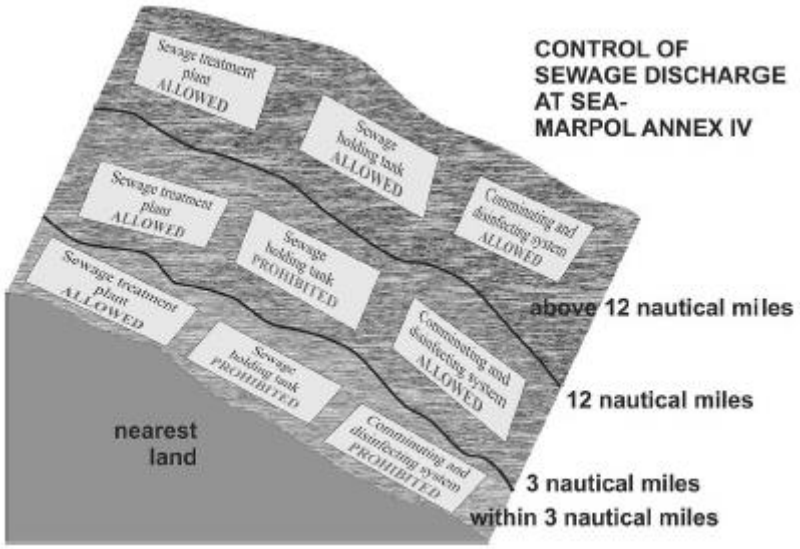
Table 11 – Legal and management issues and practices concerning sewage pollution

Sewage pollution	Issues/practices
Source	• Municipal sewers or treatment facilities • Ships (specially cruise ships)
Type of pollution	• Organic matter • Metals • Endocrine disrupters • Pathogens
Measurement	• Number of persons transported in ships
Impacts	• Public health • Ecosystems • Oxygen depletion • Adverse aesthetic impact

Management	• Prescriptive approach of regulations, based on prohibition of discharges of sewage unless treated or comminuted and disinfected at a certain distance from the nearest land, except in exceptional circumstances, under MARPOL Convention Annex IV (Figure 24)
	• Options for pollution control regulated include:
	  ◦ Sewage treatment plants
	  ◦ Control of discharges of sewages into the sea
	  ◦ Port reception facilities
	  ◦ Surveys and certification of ships: including regular surveys and International Sewage Pollution Prevention Certificate
	  ◦ Port State Control
	  ◦ Industry best practices (guidance and other resources): International Chamber of Shipping, IMO

Implementation	• Discharge restrictions based purely on shoreline proximity could be inadequate in presence of important ecological features and wildlife populations

Source: adapted from (Christodoulou-Varotsi, 2018)



Source: (Christodoulou-Varotsi, 2018)

Figure 24 – Framework of the MARPOL prohibitions of sewage discharge from ships other than passenger ships in all areas and sewage discharge from passenger ships outside special areas

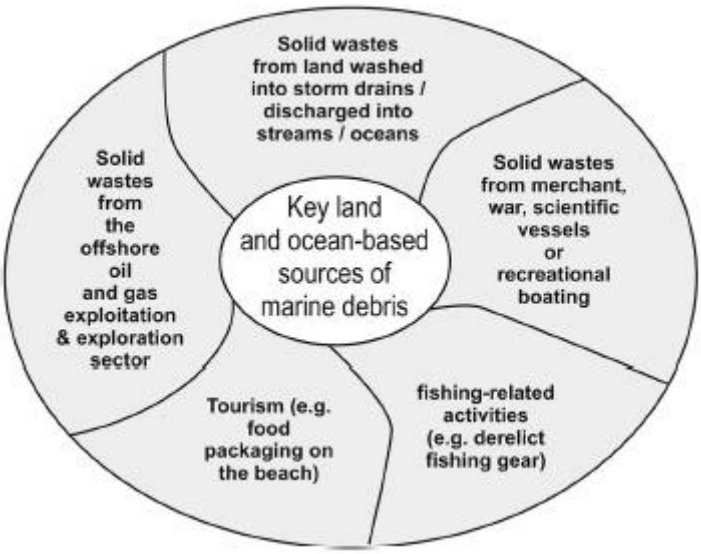
Table 12 – Legal and management issues and practices concerning waste pollution

Waste pollution	Issues/practices
Source (Figure 25)	• Land-based • Ocean-based other than shipping operations (e.g. dumping) • Shipping operations • Transboundary movements of hazardous wastes
Type of pollution	• Food wastes • Domestic wastes • Operational wastes • Plastics • Cargo residues • Cooking oil • Incinerator ashes • Fishing gear • Animal carcasses • Dredged material • Sewage sludge • Decommissioned vessels • Mining wastes
Measurement	• Garbage Record Book
Impacts	• International waters problem because of currents and winds • May cause death or injury of marine mammals, seabirds and other species (entanglement and ingestion of marine debris) • Potential danger for marine safety • Hazard to human health • Affect aesthetic view of water and coastlines

Management	• Prescriptive approach of regulations, general prohibition of garbage discharge under MARPOL Convention Annex V (garbage discharge; optional annex), conditional prohibition of dumping by the London Convention 1972 and London Protocol 1996 (waste dumping) and Basel Convention (transboundary movements of hazardous wastes) (Figure 26, Figure 27)
	• Options for garbage discharge management in shipping (not including cargo residues):
	  ◦ Reduction at source (e.g. minimise packaging)
	  ◦ Reuse or recycling
	  ◦ Onboard processing (e.g. Integrated Bilge Water Treatment System/IBTS for oily waste)
	  ◦ Limited discharge of garbage at sea (wherever is legal)

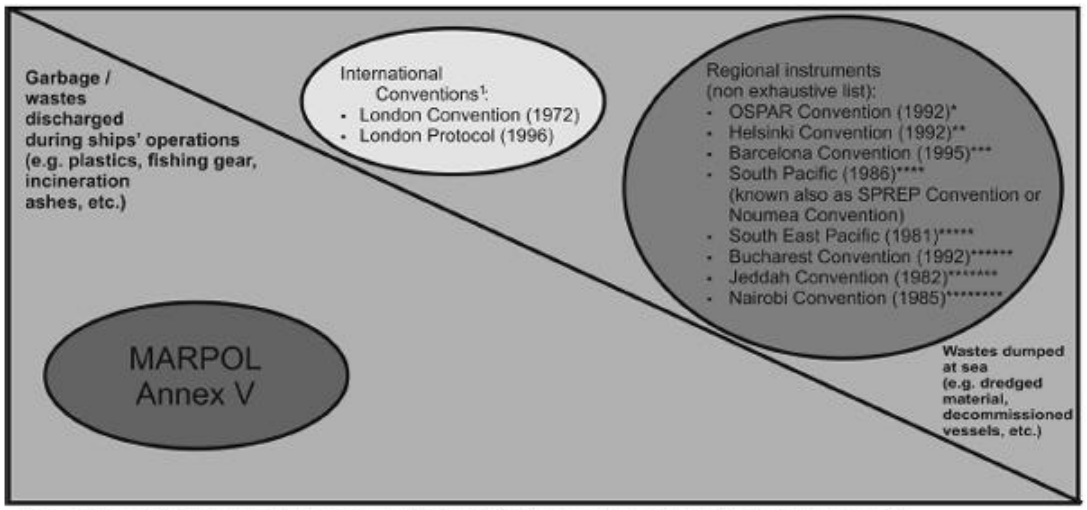
Waste pollution	Issues/practices
	• Appropriate use and adequacy of port reception facilities (including in special areas, such as the Wider Caribbean region including the Gulf of Mexico and the Caribbean Sea) • Garbage Management Plan (mandatory, procedures for minimizing, collecting, storing, processing, disposing of garbage, training) • Garbage Record Book (for record of discharges and incinerations) • Placards with key discharge requirements of Annex V • Options for waste dumping control: • Prohibition of dumping of specified wastes (black list) • Permission of dumping of specified wastes under prior special permit (grey list) • Prior general permit-related dumping of other wastes • Options for reduction of dumping: • waste prevention audit • consideration of waste management options • chemical, physical and biological properties • action list • dump-site selection • assessment of potential effects • monitoring • permit and permit conditions • Management of hazardous wastes: • Reduction of generation • Promotion of environmentally sound management • Restriction of transboundary movements • Regulation of permissible transboundary movements
Implementation	-

Source: adapted from (Christodoulou-Varotsi, 2018)



Source: (Christodoulou-Varotsi, 2018)

Figure 25 – Land and ocean-based sources of marine debris



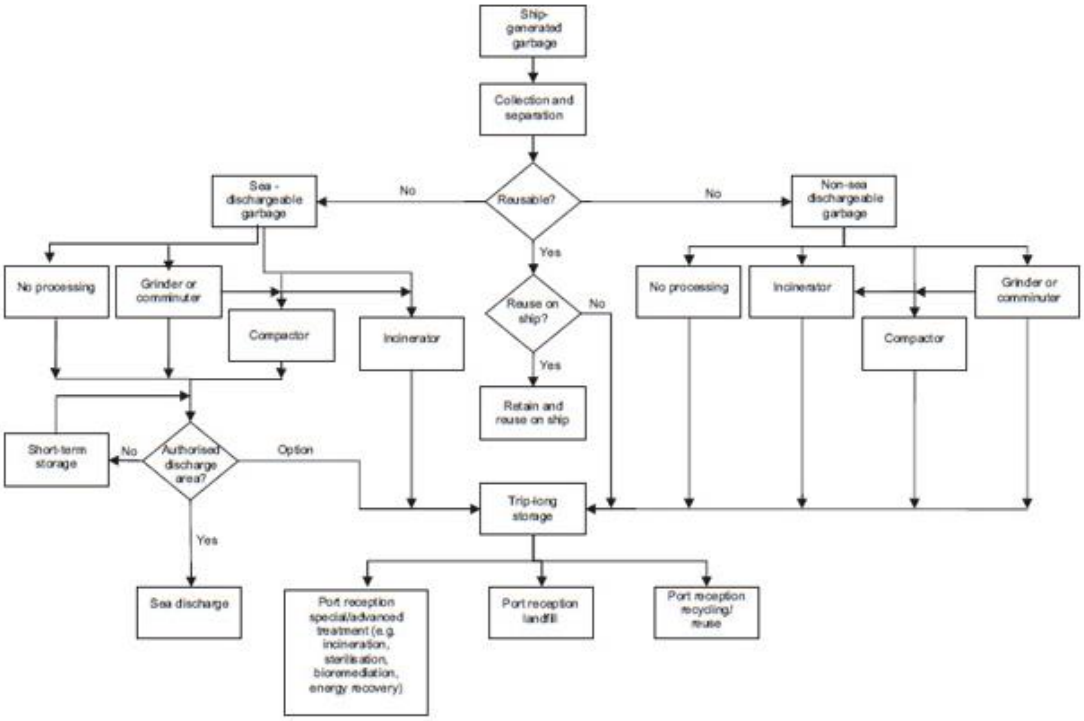
Regulation of Discharges and Dumping of Wastes at Sea (non exhaustive list of related instruments)

1. The Basel Convention on the Transboundary Movements of Hazardous Wastes and Their Disposal (1989) is also to be noted. Wastes which derive from the normal operations of a ship, the discharge of which is covered by another international instrument, are excluded from the scope of this Convention.
Note: Some of the instruments in the area on the right may also pertain to pollution from ships

* Convention for the Protection of the Marine Environment of the North East-Atlantic.
** Convention on the Protection of the Marine Environment of the Baltic Sea Area.
*** Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (this is the revision of Barcelona Convention, 1978);
**** Convention for the Protection of the Natural Resources and Environment of the South Pacific Region. Two related protocols are to be noted.
***** Protocol for the Protection of the South-East Pacific against Radioactive Pollution; the instrument prohibits the dumping of radioactive wastes in the South-East Pacific region.
****** Convention on the Protection of the Black Seas Against Pollution and the three protocols.
******* Regional Convention for the Conservation of the Red Sea and Gulf of Aden (1982), and its related legal instruments; the Convention notably addresses pollution caused by dumping from ships and aircrafts and pollution from land-based sources.
******** Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (and Related Protocols).

Source: (Christodoulou-Varotsi, 2018)

Figure 26 – Instruments for regulation of discharges and dumping at sea



Source: (Christodoulou-Varotsi, 2018)

Figure 27 – Options for shipboard handling and discharge of garbage under MARPOL Annex V

Table 13 – Legal and management issues and practices concerning chemicals pollution

Chemicals pollution	Issues/practices
Source	• Bulk carriers • Chemical, parcel or product tankers • Gas carriers • Container ships • General cargo vessels or roll-on roll-off vessels
Type of pollution	• Hazardous and noxious substances (sulphuric acid, hydrochloric acid, caustic soda, LPG/LNG, ammonia, etc.) • Form of chemical and type of ship (in bulk and in packaged form) • Operational discharges, accidental spillage or loss overboard
Measurement	• Cargo Record Book

Chemicals pollution	Issues/practices
Impacts	• Potential to impair human life (e.g. death due to explosion, injury resulting from absorption via skin contact, etc.), the environment (e.g. impact on wildlife, marine species, etc.), safety (e.g. by requiring the evacuation of local communities), and/or the economy (e.g. adverse impact on marine resources, tourism, etc.) • Damage to amenities and interference to legitimate uses of the sea • Depends on the properties of hazardous chemicals (flammability, explosivity, toxicity, infection, reactivity, corrosivity, radioactivity) and the behaviour of hazardous chemicals (dissolvers, floaters, sinkers, gases or evaporators)

Management	• Chemical classification systems (identify hazardous chemicals and provide information about related hazards through standard symbols and phrases); harmonised criteria for the classification of substances and mixtures (according to their health, environmental and physical hazards) and harmonised hazard communication elements (labelling and safety data sheets requirements):
	  • United Nations Globally Harmonized System of Classification and Labelling of Chemicals/GHS (required to be introduced in national legal systems, been done e.g. in the European Union level)
	  • Standard European Behaviour Classification/SEBC: determination of the theoretical behaviour (floaters, sinkers, dissolvers, evaporators) of a substance through examination of physical and chemical properties; criteria for evaluation of short-term distribution between water and air
	  • GESAMP hazard profiles: evaluation criteria of hazards to health and the marine environment of chemical substances that may be released from ships; identifies the hazards characteristics of a substance (bioaccumulation and biodegradation; aquatic toxicity; acute mammalian toxicity; irritation, corrosion and long-term health effects; interference with other uses of the sea)
	  • European Union Regulation 1272/2008: incorporated the GHS in the European Union; determines which properties of substances and mixtures should lead to a classification as hazardous
	• Construction requirements (IMO Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk and Code

Chemicals pollution	Issues/practices

	for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk)
	• Transport requirements (International Maritime Dangerous Goods Code, International Maritime Solid Bulk Cargoes Code, International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships; Model Regulations on the Transport of Dangerous Goods)
	• Prevention of pollution from noxious liquid substances (NLS) carried in bulk, under MARPOL Annex II:
	  • Categorisation of NLS: determining prohibition, limitation or restriction of discharges, provisions of design, construction and outfitting of new built or converted chemical tankers, ship types, etc.
	  • Surveys and certification: International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk (NLS certificate), Procedures and Arrangements Manual (procedures for cargo handling, tank cleaning, slops handling, cargo tank ballasting and deballasting), Cargo Record Book, Shipboard Marine Pollution Emergency Plan for NLS
	  • Design, construction, arrangement and equipment
	  • Discharge prohibitions with exceptions
	  • Operational discharges of residues
	  • Measures of control by port States
	  • Prevention of pollution arising from an incident
	  • Reception facilities (for tanks washings and cargo residues)
	• Prevention and minimising pollution by harmful substances in packaged form (freight containers, portable tanks, etc.), under MARPOL Annex III:
	  • Prohibition and quantity limitation of carriage of harmful substances and regulation of exceptions
	  • Packing, marking, labelling, stowage requirements
	  • Documentation requirements

Implementation	• Verification of compliance with MARPOL:
	  • Audits, Port State Control (NLS, Annex II)
	  • Ship inspections, Port State Control (Annex III)

Source: adapted from (Christodoulou-Varotsi, 2018)

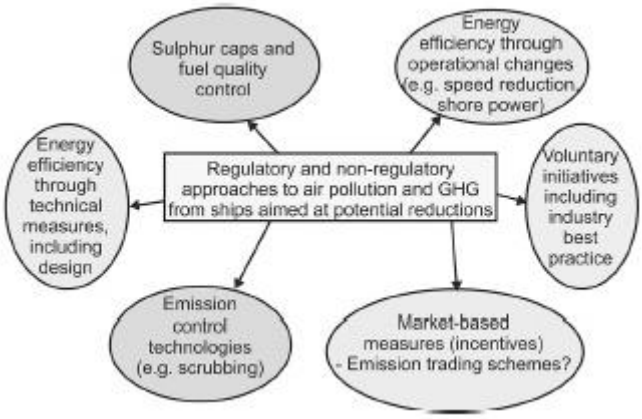
Some regulations and management practices are also provided for sulphur oxides and GHG emissions from shipping which relates to the issue of ocean acidification.

Table 14 – Legal and management issues and practices concerning sulphur oxides and GHG emissions

Sulphur oxides and GHG emissions	Issues/practices
Source	• Exhaust gases from ships main engines and auxiliary engines • Combustion of marine fuels with a high sulphur content
Type of pollution	• Ocean acidification
Measurement	• Fuel consumption of ships • Content of sulphur in marine fuels
Impacts	• Ecosystem damage • Economic loss
Management (Figure 28)	• Mandatory requirements on the quality of marine fuels (setting sulphur caps on the content of marine fuels), under MARPOL Annex VI • Regulations on energy efficiency of ships, under MARPOL Annex VI: • Energy Efficiency Design Index (EEDI): estimation of CO_2 emissions per ton-mile of goods transported relative to a reference average of similar ships; performance-based approach • IMO roadmap on the reduction of GHGs from shipping • Fuel Oil Data Collection System/FODCS (IMO) • Surveys and certification concerning air pollution (ships of 400 gross tonnage and above), obligation to maintain the equipment and prohibition to change the equipment/items covered in the survey (MARPOL) • International Air Pollution Prevention Certificate/IAPPC (ships of 400 gross tonnage and above engage in voyages under jurisdiction of EU, platforms and drilling rigs engaged in voyages under sovereignty or jurisdiction of EU) • International Energy Efficiency Certificate/IEEC, certifies ship (400 gross tonnage and above engaging in voyages under jurisdiction of EU) survey and ship compliance with requirements

Sulphur oxides and GHG emissions	Issues/practices
	• Ship Energy Efficiency Management Plan, reduce CO_2 emissions through optimisation of performance of operations (mandatory in new and existent ships but without requirements of the result to be achieved); includes an Energy Efficiency Operational Indicator (EEOI); can include practices such as improved voyage planning, weather routeing, just in time, speed optimization, optimized shaft power, optimized ship handling, etc. • Regulation of a reduction of the sulphur content of certain liquid fuels in EU flag-ships and EU ports, under Directive (EU) 2016/802 ("the Sulphur Directive") and SOx Emission Control Areas (Baltic Sea, North Sea and English Channel) • Monitoring, reporting and verification/MRV regulation (EU) for CO_2 emissions of large vessels (ships over 5,000 gross tonnes) using EU ports (per-voyage and annual basis), based on fuel consumption of ships; including a document of compliance
Implementation	• Port State Control: inspection in case of suspicion of not complying

Source: adapted from (Christodoulou-Varotsi, 2018)



Source: (Christodoulou-Varotsi, 2018)

Figure 28 – Regulatory and non-regulatory approaches to air pollution and GHG from ships aimed at potential reductions

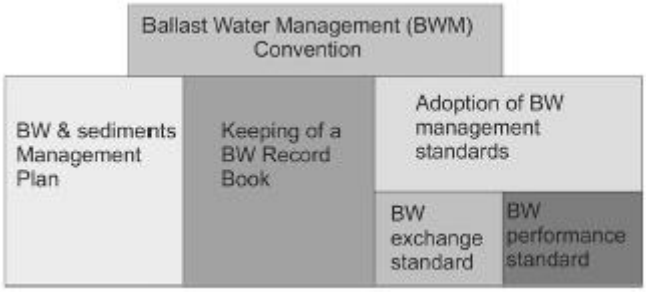
Table 15 – Legal and management issues and practices concerning other pollution sources

Other pollution	Issues/practices
Source	• Ballast water • Anti-fouling systems • Ship-dismantling activities • Collisions between cetaceans and ships • Activities producing noise (shipping, use of sonar systems, offshore oil and gas platform construction, dredging for shipping lanes, military activities, etc.)
Type of pollution	• Transfer of living species (non-native bacteria, microbes, aquatic plants or animal species) • Harmful substances (TBT, ship materials) • Underwater noise
Measurement	• EU monitoring of underwater noise
Impacts	• Distortion of biodiversity, human health and economy • Risk of toxicity and other adverse impacts on health and the environment • Cetaceans carcasses at sea or blood in the water and damage to vessels • Adverse effects of noise on natural processes, including interference with critical life functions of marine animals (e.g. large whales, many fish and some seals and sea lions)

Management	• Not within the confines of MARPOL
	• Ballast Water Management Convention 2004 (BWM Convention) and associated IMO guidelines (Figure 29):
	  ◦ Ballast water management standards: exchange standard or performance standard
	  ◦ Surveys and certification (ships of 400 gross tonnage and above)
	  ◦ Ballast Water Management Plan
	  ◦ Ballast Water Record Book, recording operations concerning ballast water
	• International Convention on the Control of Harmful Anti-fouling Systems on Ships/AFS:
	  ◦ Phase-out of harmful organotin compounds (TBT-organotin Tributyltin)
	  ◦ Mechanism for the prevention of potential use of other harmful substances in anti-fouling systems
	  ◦ Surveys and certification

Other pollution	Issues/practices
	• Best management practices • EU Regulations (782/2003 and 536/2008) concerning anti-fouling systems • Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships: duties for ships, ship-recycling facilities and flag States; authorisation and regulation of recycling ship facilities (prevention of unsafe conditions, accidents, spills or emissions), regulation of design, operation and maintenance of ships, surveys and certification of ships; Ship Recycling Plan, Ship Recycling Facility Plan, Statement of Completion (when partial or complete recycling is completed) • EU regulation (1257/2013) concerning ship recycling • IMO guidance in reducing and minimising the risk of ship strikes of cetaceans: including avoidance of areas with known concentrations of whales and reduction of speed while transiting those areas, non-mandatory guidelines for the reduction of underwater noise from commercial shipping • EU monitoring of underwater noise, under the Marine Strategy Framework Directive/MSFD (Directive 2008/56/EC) and the Environmental Impact Assessment Directive/EIA (Directive 2011/92/EU)
Implementation	• Port State Control: verification of certificate, inspection, sampling of ship's ballast water

Source: adapted from (Christodoulou-Varotsi, 2018)



Source: (Christodoulou-Varotsi, 2018)

Figure 29 – Requirements under the Ballast Water Management (BWM) Convention

The document also presents practices concerning **preparedness, response and cooperation** in the context of marine pollution, referring to coordination and mutual assistance and also to the right of intervention of coastal States on the high seas.

Key stakeholders in this context include:

- IMO: not an operational organisation, it is involved under the OPRC Convention and OPRC-HNS Protocol in tasks related to information services, education and training in pollution preparedness and response, technical services and technical assistance; may also engage in funding;
- United Nations Environment Programme: created regional approaches to marine pollution and management under regional sea programmes and contributed together with IMO to regional marine pollution emergency response centres;
- European Maritime Safety Agency: technical arm of the European Commission in the development and implementation of maritime policies on maritime safety, maritime security and protection of the marine environment at large; engages in operational tasks in the area of marine pollution response, vessel monitoring, and long-range identification and tracking of vessels;
- Other: International Criminal Police Organization (ICPO-INTERPOL), with important role in cooperation against environmental crime.

Main actions are presented in Table 16.

Table 16 – Main actions concerning preparedness, response and cooperation in marine pollution

Framework	Preparedness, response and cooperation actions

OPRC Convention (oil pollution)	• National level:
	  • National response system, including authorities, contact points and national contingency plan
	  • Oil pollution emergency plan (ships, offshore units, ports and oil handling facilities)
	  • Incident reporting
	  • Developing and maintaining response capacity (equipment, programme of exercises and training, plans and communication capabilities, co-ordination)
	• International level:
	  • Informing neighbouring countries of oil spill that could affect them
	  • Provide assistance when required
	  • Facilitation of assistance received

OPRC- HNS Protocol (chemical pollution)	• Pollution Incident Emergency Plan for ships, ports, facilities handling chemicals • National response system, including authorities, contact points and national contingency plan • Developing and maintaining response capacity (equipment, programme of exercises and training, plans and communication capabilities, co-ordination)
Spill response contracts	• Standard contracts for the hire of spill response services and equipment, containing essential contractual aspects that would avoid delays

Regional frameworks	• Regional agreements relative to a particular sea area, e.g. under a regional convention or regional seas programme of UNEP
	• Bilateral/Trilateral/Multilateral agreements
	• Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea/REMPEC:
	  • Under Barcelona Convention on the protection of the Mediterranean Sea, its Prevention and Emergency Protocol and Regional Strategy for Prevention and Response to Marine Pollution from Ships
	  • Enhancement of the capacities of coastal States in order to prevent marine pollution from ships
	  • Development of regional cooperation in the area of marine pollution prevention

Framework	Preparedness, response and cooperation actions
	• Assistance to coastal States of the Mediterranean where they request so in developing their own capabilities • Exchange of information on best practice • Facilitating assistance to coastal States in cases of emergency

Source: adapted from (Christodoulou-Varotsi, 2018)

Chemical pollution preparedness and response faces a harder implementation than oil due to several factors:

- Failure to adhere to the international system on preparedness, response and cooperation, contributing to nonuniformity;
- Poor implementation, e.g. non robust legislative framework or poor implementation of that framework, due to lack of willingness to ensure standards are mete, limited resources (e.g. equipment, training, waste disposal areas) and weak enforcement mechanisms.

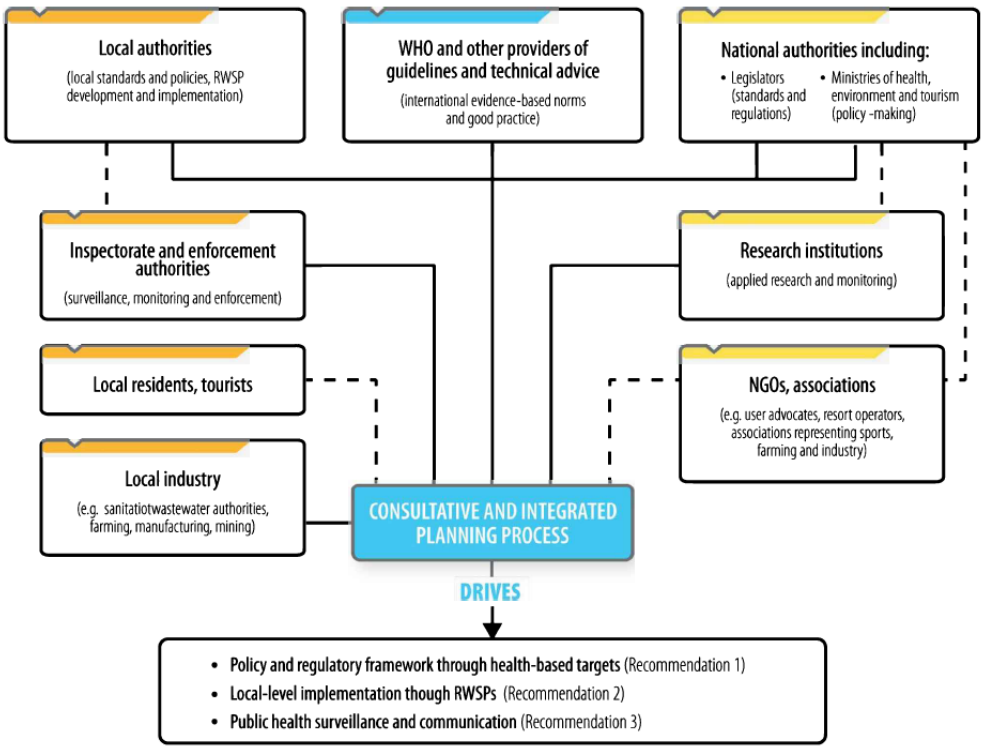
3.3.4. WHO Guidelines on recreational water quality – coastal and fresh waters

The document (WHO, 2021) addresses the health hazards associated with recreational use of coastal and freshwater environments, with an exclusive focus on water quality. These guidelines provide a review and assessment of the current state of knowledge on potential adverse health effects and make recommendations, in particular on:

- National health-based targets;
- Risk assessment;
- Approaches to identify, monitor and control hazards;
- Public health surveillance;
- Communication.

The main objective of these guidelines is to protect public health by assuring that recreational waterways are managed as safely as possible so that the maximum number of people can benefit. The primary audience for these guidelines is those responsible for promoting a safe recreational water environment, including national and local authorities, as well as owners or service providers and their staff. In addition, non-governmental organisations (NGOs) and users have an important role to play in preventing health risks (Figure 30).

The guidelines are designed to be applicable to any coastal or freshwater area. To properly apply the guidelines national and local agencies will need to take into account the social, cultural, environmental and economic characteristics of each site, so the standards developed may vary between and within regions due to differences in these factors.

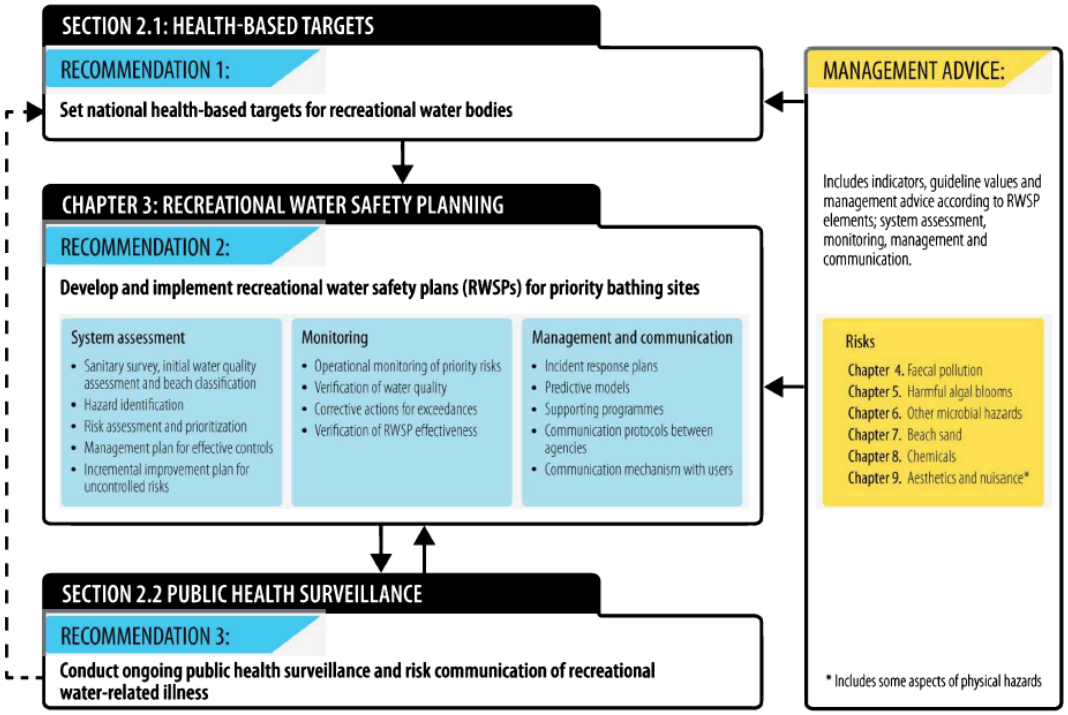


Source: (WHO, 2021)

Figure 30 - Stakeholders in recreational water environments

Key recommendation for the implementation of these guidelines by responsible authorities is the development of a **national Recreational Water Safety Framework** (RWSF), based on the recommendations and management advice for specific hazards, which should include (Figure 31):

- Health-based targets
- Recreational Water Safety Plan (RWSP)
- Public Health surveillance



Source: (WHO, 2021)

Figure 31 - Recreational Water Safety Framework

Health-based targets are quantifiable objectives for performance, water quality or health, set in response to risk assessments for waterborne hazards and safety assessments. For recreational waterways, there are two different categories of health-based objectives, namely health outcome targets (e.g., cases of illness) and water quality targets (e.g., guideline values for microbial indicators).

Figure 32 depicts the core recommendations related to health-based targets.

Recommendation 1: Set national health-based targets for recreational water bodies

Subrecommendations

1.1 Express targets as **microbial water quality standards** for sources of faecal contamination based on the guideline values in Table 2.1.[1]

1.2 Develop additional water quality standards for cyanotoxins or biovolume indicators from harmful algal blooms based on guideline values in Fig. 5.1.

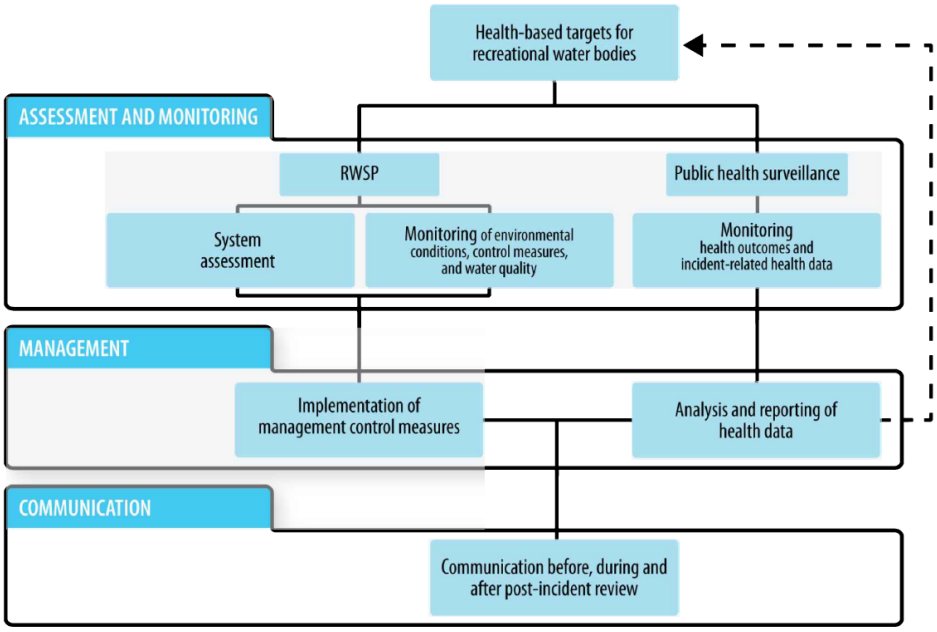
1.3 Consider additional standards based on provisional guideline values for beach sand and chemicals, operational monitoring limits for other microbial hazards, and aesthetic and nuisance aspects if justified by national or local risk assessment and resource availability for monitoring and control measures.

Source: (WHO, 2021)

Figure 32 - Health-based targets recommendations

Public health surveillance of recreational waters entails the collection, analysis and interpretation of health-related data on suspected or confirmed illnesses in people exposed to contaminants in recreational waters. It also includes risk communication derived from water quality monitoring and managed under an RWSP (Figure 33).

Figure 34 illustrates the main recommendations related to public health surveillance.



Source: (WHO, 2021)

Figure 33 - Public health surveillance and risk communication process

Source: (WHO, 2021)

Figure 34 - Public health surveillance recommendations

Recreational Water Safety Plans (RWSPs) provide those responsible for managing recreational waters with a comprehensive and useful method for assessing and controlling risks associated with water recreation. RWSPs compile information on recreational water sites, focusing on hazardous sources, events that could cause water pollution and potential risks to public health. To address the latter, the RWSP includes sound management and monitoring approaches.

RWSPs are designed and operated according to health-related objectives and effectiveness. These objectives and effectiveness are evaluated through continuous monitoring (Figure 35).

Recommendation 2: Develop and implement recreational water safety plans (RWSPs) for priority bathing sites

Subrecommendations (also refer to Box 3.4 checklist for developing RWSPs)

2.1 Identify the lead entity and **assemble a team to develop the RWSP.**

- Identify the lead entity and key stakeholders, and form a coordination committee that includes relevant stakeholder representatives with clear roles and responsibilities.

2.2 Undertake a **system assessment** for each existing priority recreational water site (or group of sites within the same catchment) and before developing new sites.

- Describe the recreational water environment – by combining a sanitary survey of adjacent land and water drainage with an initial microbial quality assessment to assign a beach classifications (refer to sections 4.1–4.3).
- Identify hazards and hazardous events, considering seasonality and predicted local climate change scenarios.
- Assess and prioritize the risks.
- Identify existing control measures, assess risks and prioritize risks that are insufficiently controlled.
- Establish plans, with sustainable funding, for managing currently effective control measures.
- Establish improvement plans, with sustainable funding, for incrementally implementing control measures where priority risks are insufficiently controlled.

2.3 Conduct and maintain **system monitoring.**

- Establish and implement an operational monitoring regime for priority control measures in the catchment to give rapid warning when operational limits are exceeded.
- Establish and implement corrective actions for exceedances of operational limits.
- Conduct ongoing verification monitoring of water quality.
- Establish procedures to verify effectiveness of the RWSP.

2.4 Establish coordinated **management and communication** strategies to support effective pollution control and public communications.

- Document management procedures for normal and incident conditions, including incident response plans.
- Where feasible, develop predictive models to support timely communication to water users.
- Develop supporting programmes – for example, training, research and development, standard operating procedures, quality control activities, procedures for visual inspections, sample collection and equipment calibration.
- Establish communication protocols between responsible organizations and agencies.
- Establish mechanisms for communication with users and managers of the site.

2.5 **Review and update** RWSPs.

- Meet periodically and after incidents to review performance of plans, including operational monitoring and water quality results, an updated sanitary survey and beach classification, the occurrence of incidents, communication and complaints; if necessary, update the risk assessment.

Source: (WHO, 2021)

Figure 35 - RWSP recommendation

RWSPs have three components: system assessment, monitoring, and management and communication (Figure 36).

Component	Activity
Preliminary	• Identify the lead entity and assemble the RWSP team.
System assessment	• Describe the recreational water environment (using a sanitary survey, and historical water quality results or classification). • Identify hazards and hazardous events (e.g. untreated or partially treated wastewater contamination, epidemiological data). • Assess the risks. • Identify existing control measures (e.g. offshore wastewater outfalls). • Identify risks that are insufficiently controlled. • Prioritize uncontrolled risks.
Monitoring	• Define operational monitoring. – Establish a monitoring regime to give rapid warning when operational limits are exceeded. – Where possible, establish corrective actions for exceedances of operational limits. • Identify verification monitoring. • Establish procedures to verify effectiveness of the RWSP.
Management and communication	• Document management procedures for normal and incident conditions. • Develop supporting programmes. • Establish communication protocols between responsible organizations and agencies, and mechanisms for communication with users of the site.

Source: (WHO, 2021)

Figure 36 - RWSP components

The document covers a wide range of specific hazards related to pollution of the marine environment, in particular:

- Faecal pollution;
- Harmful algal blooms (data only available for freshwater environments);
- Other microbial hazards;
- Beach sand;
- Chemicals;
- Aesthetics and nuisance.

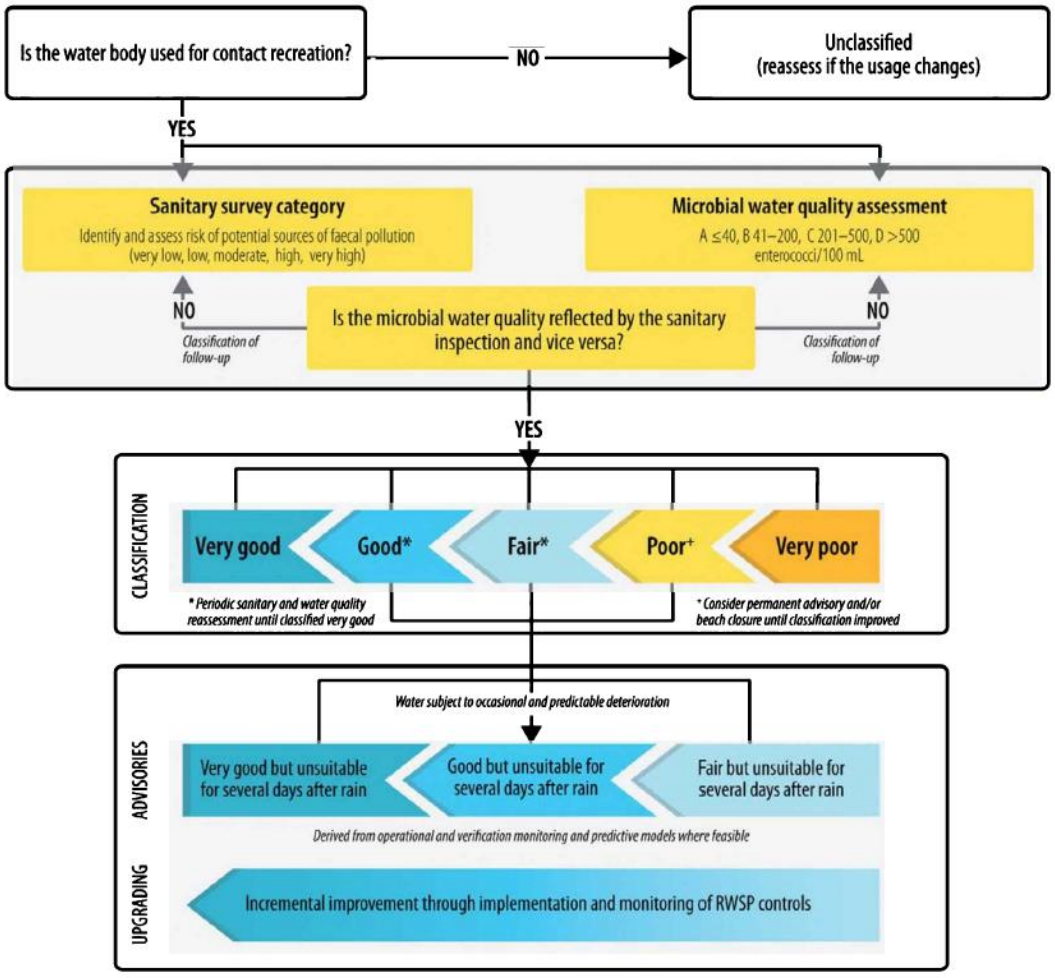
For each of the above health threats, management advice is summarised below (Table 17 to Table 21) according to the relevant water quality indicator and its guideline values and the three elements of an RWSP (system assessment, monitoring, management and communication).

Table 17 - Management advice and recommendations for faecal pollution

Faecal pollution	Issues/practices
Indicator and Guideline value	• Faecal Indicator Organism (FIO) – Intestinal enterococci • Guideline value – 200/100 mL (upper 95th percentile) - If necessary, adapt guideline values in national standards based on high quality local epidemiology
System assessment	• Combination of water quality tests and sanitary surveys - Undertake a sanitary survey to identify all sources and conditions leading to faecal pollution - Determine recreational water quality from an initial microbial water quality assessment - Classification of the recreational water environment (Figure 37) • Undertake further assessment, and possibly on-site empirical investigations, if there is discrepancy between the results of the microbial water quality assessment and the sanitary survey • Consider upgrading the beach classification to a more favourable level if local management actions are effective
Monitoring	• Undertake initial microbial water quality assessment to inform beach classification • When unacceptable levels of FIOs are detected and sewage is not the likely source, identify faecal source contributing FIOs • Monitor the functioning of control measures using operational (microbial and nonmicrobial) parameters and predictive modelling to allow timely warning to water users • Conduct ongoing verification monitoring to check whether water quality is likely to be high enough to meet health-based targets

Faecal pollution	Issues/practices
Management and Communication	• Enforce compliance with regulations. For catchment pollution from human or nonhuman sources, identify major sources of pollution and develop a catchment-wide pollution abatement programme • Manage pollution of recreational waters by human or animal wastes containing faecal bacteria or pathogens through system upgrades • Public Health authorities should be engaged in defining water quality standards or appropriate triggers relevant to exceptional circumstances • Develop predictive models for real-time operational monitoring and public communications • Post advisory notices of likely adverse water quality if: - Weather events, such as high rainfall, lead to elevation of FIOs - A rare or extreme event causes gross pollution of the bathing water - Sewage, septic tank effluent and/or faecal sludge discharges occur that are unrelated to weather events

Source: (WHO, 2021)



Source: (WHO, 2021)

Figure 37 – Flowchart for assessing recreational water environments

Table 18 - Management advice and recommendations for other microbial hazards

Other microbial hazards	Issues/practices
Indicator and Guideline value	• Not applicable – no dose-response relationship can be established for these organisms
System assessment	• Incorporate risk factors for the other microbial hazards of concern for the catchment within the RWSP system assessment by preparing an inventory of microbial hazards that have been observed or are likely to be present and incorporating risk factors
Monitoring	• For organisms whose prevalence is strongly dependent on environmental conditions, incorporate indirect operational monitoring of environmental conditions into RWSPs • Undertake verification monitoring and surveillance of illness at a national level, to enable analysis of information on symptoms, severity, pre-existing conditions and the likely recreational source of infection • Regular pathogen monitoring is not recommended except under exceptional circumstances (and if site-specific guideline values are established) – for example, before and after a water sports event, or during heatwaves in locations with history of Vibrio infections. Targeted screening can be used for investigative and research purposes
Management and Communication	For health authorities and water managers: • In catchments and bathing sites where severe infections are suspected, incorporate pathogen specific management and communication measures into the RWSP • Potential control measures include site management and behaviour change approaches • Where non-native animal carriers play a role in disease transmission, manage the recreational site to control these animals • Where a site has been linked to infection or has conditions that are suitable for the causative organism, inform site users to allow them to make an informed decision For recreational water users: • General precautions - Cover existing skin with waterproof dressings before entering the water. - Remove wet swimwear; shower and towel dry after exposure - Remove contact lenses before bathing in warm fresh water

Other microbial hazards	Issues/practices
	- For water sports, wear protective clothing where the risk of infection is high - If an infection develops after recreational water exposure, seek medical advice • Specific precautions: - Protect against swimmer's itch by avoiding high-risk areas and high-risk periods - Reduce exposure to Naegleria fowleri by minimizing the amount of naturally warm fresh recreational water entering the nose - People with underlying medical conditions should limit their exposure to brackish water or seawater - Seek medical advice if planning to engage in recreational water activities in areas where human schistosomiasis and leptospirosis are endemic For medical practitioners: • Pay attention to risk behaviours such as travel to endemic areas, adventure travel and extreme water sports

Source: (WHO, 2021)

Table 19 - Management advice and recommendations for beach sand

Beach sand	Issues/practices
Indicator and Guideline value	• Intestinal enterococci • Guideline value – 60 CFU/g - Where resources allow, adapt the provisional guideline value in national standards based on local epidemiological and quantitative microbial risk assessment studies. In the absence of guideline values, efforts should focus on prevention measures
System assessment	• Incorporate risk factors for pathogens of concern in beach sand into RWSP system assessment, paying particular attention to beaches that are vulnerable from a physical and geomorphological perspective
Monitoring	• Undertake pathogen sampling and analysis • Undertake operational monitoring of priority sources of sand pollution
Management and Communication	For health authorities and water managers: • Limit access to the beach by dogs and feral animals • Prepare management plan for birds • Provide properly designed solid waste disposal facilities • Provide toilet facilities, appropriate wastewater and sludge treatment, and stormwater drainage • Conduct beach grooming to eliminate visible solid waste • Check the quality of source sand if beach sand renourishment is used to build artificial beaches or restore natural beaches • Apply additional strategies for beaches that are vulnerable from a physical and geomorphological perspective For recreational water and beach users (in the absence of environmental measurements): • Use towel when sitting on the beach • Wear shoes to minimize cuts when walking on the beach • Protect open wounds from water and sand exposure • Beach clean-up workers may be encouraged to wear protective clothing, including gloves and possibly dust mask • Shower upon leaving the beach For public authorities: • Stay in contact with lifeguards for potential reports of on-site outbreaks • Proactively intervene by contacting medical centres – remind staff to be alert to possible beach related outbreaks and ailments.

Source: (WHO, 2021)

Table 20 - Management advice and recommendations for chemicals

Chemicals	Issues/practices
Indicator and Guideline value	• None indicator – except for specific chemicals where justified by national or local risk assessment, and resource availability for monitoring and control measures • Guideline value - as screening approach, investigate substances occurring in recreational water at a concentration 20 times higher than the guidelines value in the WHO Guidelines for drinking-water quality
System assessment	• Incorporate assessment of chemical hazards in recreational waters into RWSPs, using information on potential sources of chemical hazards within the catchment, and the frequency, extent and likelihood of exposure
Monitoring	• Undertake operational monitoring for the high-risk chemical discharges; monitor fencing and signage, if installed, to prevent access to water bodies that are permanently unsuitable for recreational use; monitor soil and groundwater downstream of contaminated sites • Use chemical analysis to support quantitative risk assessment if contamination is present or suspected and there is significant exposure of users
Management and Communication	For health authorities and water managers: • Manage pollution events, and provide timely and effective information about recreational water environments affected by chemical hazards For recreational water users: • Provide information about the nature of the contaminations, potential health risks, activities to be avoided and planned remedial action

Source: (WHO, 2021)

Table 21 - Management advice and recommendations for aesthetics and nuisance

Aesthetics and nuisance	Issues/practices
Indicator and Guideline value	• Not applicable
System assessment	• Incorporate aspects of aesthetics and nuisance into RWSP system assessment
Monitoring	• Local authorities and/or citizen science can undertake periodic operational monitoring via visual inspection and data collection on priority aesthetic aspects of concern.
Management and Communication	For health authorities and water managers • Provide solid waste disposal facilities • Undertake beach grooming and litter clean-ups for beaches receiving litter or excessive macroalgae from offshore • Provide information to beach users on proper solid waste disposal, and avoiding nearshore nuisances such as jellyfish • Undertake insect control for sites with excessive mosquitoes, flies and other nuisance insects • Develop policies and management for non-native animals on the beach. If dogs are permitted, put in place policies and procedures to minimize their impacts on the aesthetic quality of the beach

Source: (WHO, 2021)

3.3.5. Marine Strategies for Portuguese Marine Waters / Madeira Islands

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008, or the Marine Strategy Framework Directive (MSFD), establishes a framework for Community action requiring Member States to take the necessary measures to achieve or maintain good environmental status in the marine environment.

The MSFD aims to protect, preserve, enhance and prevent the deterioration of the marine environment through the implementation of marine strategies based on an ecosystem approach to achieve a sustainable balance between the pressures from human activities and the conservation of marine ecosystems. To this end, the Directive requires each Member State to draw up and implement a strategy for the marine waters under its sovereignty or jurisdiction.

This strategy must be based on an economic and social analysis of marine water use. While not specifying a methodology for that analysis, the application of the MSFD requires, as referred, the use of an **ecosystem approach**:

- A strategy for the land, water and living resources integrated management, which promotes the conservation and sustainable and equalitarian use of resources;
- Based on the application of adequate scientific methods, focused in the several levels of biologic organization, spanning the structure, processes, functions and interactions between organisms and their environment, recognizing human beings as part of ecosystems.

Therefore, the chosen methodology must consider the relation between human activities and associated pressures as well as the impacts of these pressures in the ecosystems and human well-being. As the scientific knowledge is often limited or incomplete, it is demanded the application of the precautionary principle as a central part of the ecosystem approach.

This section presents the Marine Strategy for the Portuguese marine waters of the subdivision of Madeira Islands (Governo de Portugal, 2014), which includes the national marine waters around the archipelago of Madeira, excluding the extended continental shelf, and includes the subdivision of Macaronesia.

The first part of the preparation phase of marine strategy included an **initial assessment of the current environmental status** of national marine waters and the **environmental impact of human activities** in these waters. The assessment addressed eleven descriptors, listed in Annex I of the MSFD, which qualify the good environmental status of EU marine waters and relate to the conservation of biodiversity, the quality of marine waters, the structure and function of ecosystems, and pressures and impacts on the marine environment, of which four (4) are related to marine pollution (Table 22).

Table 22 - Descriptors of the MSFD for the assessment of the environmental status of marine waters

Descriptor	Description	Marine Pollution
D1. Biodiversity	Biodiversity is conserved. The quality and occurrence of habitats and the distribution and abundance of species are consistent with the prevailing physiographic, geographic and climatic conditions.	
D2. Non-indigenous species	Non-indigenous species introduced by human activities are at levels that do not adversely alter ecosystems.	
D3. Commercially exploited fish and shellfish stocks	Populations of all commercially exploited fish and shellfish are within safe biological limits, with age and size distributions indicating good stock status.	
D4. Marine food chain	All elements of the marine food chain, insofar as they are known, are present at normal levels of abundance and diversity and at levels that will ensure the long-term survival of species and the maintenance of their full reproductive capacity.	
D5. Anthropogenic eutrophication	Anthropogenic eutrophication will be minimised, in particular its negative impacts such as biodiversity loss, ecosystem degradation, harmful algal blooms and oxygen depletion in deep waters.	✓
D6. Seabed integrity	The level of seabed integrity ensures that the structure and functions of the ecosystems are safeguarded and that benthic ecosystems, in particular, are not adversely affected.	
D7. Hydrographic conditions	Marine ecosystems are not adversely affected by permanent changes in hydrographic conditions.	
D8. Contaminants in the marine environment	Contaminant concentrations do not cause pollution effects.	✓
D9. Contaminants in fish and seafood for human consumption	The levels of contaminants in fish and other seafood intended for human consumption do not exceed the levels laid down in Community legislation or in other relevant standards.	✓
D10. Marine litter	The nature and quantity of the marine litter does not cause any damage to the coastal and marine environment.	✓

Descriptor	Description	Marine Pollution
D11. Energy and noise underwater	The energy input, including the underwater noise, is kept at a level that does not have a negative impact on the marine environment.	

Source: (Governo de Portugal, 2014)

The MSFD establishes that a set of environmental goals with associated indicators must be developed to guide progress towards the good environmental state of marine waters accounting for pressures and impacts and compatibility with relevant already in-force environmental goals. The environmental goals defined in MSFD can be of the following nature:

- State goal: related with the state of a marine environment component, indicating the physical, chemical or biological condition of the environment;
- Pressure goal: related with the pressure level in marine environment, establishing the desired of accepted level for a pressure;
- Operational goal: related with the nature of the management actions required, but without establishing directly a specific measure.

The environmental goals established for the sub-division of Madeira Islands are presented in Table 23.

Table 23 – Environmental goals under MSFD for Madeira Islands

Environmental goals	Nature of goal	Descriptor
To promote the knowledge of habitats and marine biocenoses, particularly those existing in the coastal strips, in order to obtain quantitative and qualitative information that allows the definition of an initial state and areas of occurrence (mapped). To establish monitoring programs aiming at maintaining and/or recovering coastal habitats	State	D1,D2,D3,D6
Exploiting black scabbardfish in a sustainable way	Operational	D3
Study, reformulate and manage the monitoring networks that allow collecting information to support the characterization of the marine environment, with emphasis on situations that require greater attention to maintain or achieve Good Environmental Status and for those that can reveal causal relationships between the monitoring results and human activities	Operational	D1, D2, D3, D4, D5, D6, D7, D8 e D9
Map and monitor the meteo-oceanographic system at the subdivision scale (including, local wind-induced surface waves and currents, as well as open ocean and deep-sea currents) in order to improve the assessment of the environmental conditions and energy potential of the various environmental descriptors, and to assist decision processes	Operational	D1, D4, D5, D6, D7, D8, D10, D11
To study and understand the migratory routes of species of wide geographical distribution in order to highlight the relevance and ecological importance of the archipelagic seas and seamounts in the ecosystem continuum, and their oceanic and global dimension	Operational	D1, D3 e D4
Promote and systematize the knowledge of trophic networks of both coastal habitats and deep-sea ecosystems, including the study of key organisms, as well as the effect of seasonal variations, with a view to developing new indicators for future evaluation of the state of trophic networks and thus adequately define their Good Environmental Status	Operational	D1, D3 e D4
To enlarge by 2020 the Marine Protected Area (of the subdivision (currently 2083 Km2), aiming at the protection and conservation of priority species and habitats	Operational	D1, D3, D4, D6, D10 e D11

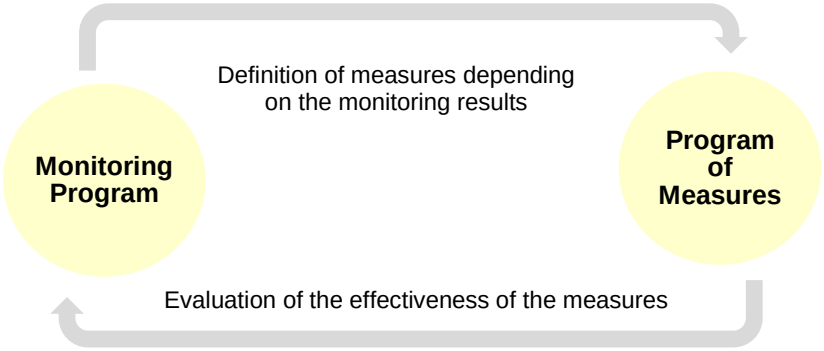
Environmental goals	Nature of goal	Descriptor
Develop studies to obtain data to characterize the quantity, distribution and composition of microparticles, and their evolution over time. Establish protocols with the sampling procedures and respective methodology for evaluating the results	Operational	D10
Track and systematize the results of scientific studies on the cause-effect relationship between marine litter, biota, and the marine environment, select for the Madeira Islands sub-division the most suitable biological indicator to assess the impact of marine litter on biota, and establish the appropriate protocols	Operational	D2 e D10
Assess the potential of the Selvagens Islands as an area of excellence for monitoring marine debris in the Atlantic and how it is transported, seeking to create an indicator of the functioning and environmental status of ocean currents	Operational	D2 e D10
Prepare a study that assesses the conditions and resources needed for the installation and operation of underwater acoustic noise monitoring devices	Operational	D11

Source: adapted from (Governo de Portugal, 2014)

The second part of the preparation phase includes the development of **Monitoring Program** (MPo) and a **Program of Measures** (PMe).

The Monitoring Program seeks to comprehensively monitor the environmental condition of national maritime waters in relation to the environmental goals set forth in the Initial Report, taking into account pertinent biotic and abiotic elements as well as the primary pressures and consequences. While the Program of Measures intends to promote or maintain a healthy environment.

The monitoring and measures programs are therefore related: the PMe uses the monitoring to identify, define, and create new measures that may be necessary in light of the data acquired in the MPo, in turn, the MPo must be structured to assess the success of the measures described in the PMe (Figure 38).



Source: adapted from (Governo de Portugal, 2014)

Figure 38 - Relationship between the Monitoring Program and the Measurement Program

For the development of the MPo the following procedure should be taken accordingly to the MSFD:

1. Provide information for an assessment of the environmental status and for an estimate of the distance from, and progress towards, good environmental status and with the criteria and methodological standards to be defined in the Directive;
2. Ensure the generation of information to identify appropriate indicators for the environmental goals;
3. Ensure the generation of information that allows the evaluation of the impact of the measures;
4. Include activities to identify the cause of the change to good environmental status, and subsequently, the possible corrective measures to be taken to restore the good environmental status when deviations from the desired status range are identified;
5. Provide information on the presence of chemical contaminants in species intended for human consumption from commercial fishing areas;
6. Include activities to confirm that the corrective actions produce the intended changes and not undesirable side effects;
7. Aggregate the information based on marine regions or sub-regions;
8. Ensure comparability of assessment approaches and methods within and between marine regions and/or subregions;
9. Formulate technical specifications and standardized methods for monitoring at the community level in order to enable comparability of information;

10. Ensure, as far as possible, compatibility with existing programs established at the regional and international level, fostering coherence between these programs and avoid duplication of efforts, using the most relevant monitoring guidelines for the marine region or subregion concerned;
11. Include, as part of the initial assessment, an assessment of major changes in environmental conditions as well as, where necessary, new or emerging problems
12. Analyse, as part of the initial assessment, the relevant elements set out in the Directive and their natural variability and assess trends with regard to the achievement of the environmental goals, using, as appropriate, the established indicators and their limit and target reference points.

Given the need to monitor contaminants in commercial species, the PMo has been structured around four axes that guide the development of the different types of monitoring included in the Monitoring Fact Sheets. The PMo will be developed along the following axes:

- Axis I - Monitoring of contaminants in species of commercial interest for human consumption;
- Axis II - Monitoring of descriptors that were considered not to have reached good environmental status;
- Axis III - Monitoring of descriptors for which there is evidence that they may deviate from good environmental status in the next 5 years;
- Axis IV - Monitoring of human activities that may negatively affect marine protected areas and other sensitive marine areas of high natural value.

Table 24 shows the marine pollution monitoring projects defined for the sub-division of Madeira Islands.

Table 24 - Monitoring projects for marine pollution for Madeira Islands

Descriptor	Monitoring project	Ecosystem components, pressures and impacts monitored	Indicators[1]
Contaminants in fish and seafood for human consumption	**CEIC** Chemical contaminants in species of commercial interest in the portuguese maritime area	Contamination of commercial pelagic, demersal and deep-sea species by hazardous substances	• Levels, number and frequency of contaminants • Actual levels of contaminants detected and number of contaminants exceeding maximum regulatory levels • Frequency of regulatory levels exceeded
Marine litter	**DELIXOMAR** Properties and Spatial Distribution of Marine Litter and Impacts on Marine Life	Marine litter and systematic and/or intentional release of substances into seabed and water column habitats and associated biological communities	• Characteristics of the garbage present in the marine and coastal environment • Trends of composition, spatial distribution, quantity of litter: - Washed ashore and/or deposited on the shore - Water column (including that floating on the surface) and deposited on the seabed - Micro-particles - Ingested by marine animals

Notes: 1- In accordance with Commission Decision nº 2010/477/UE, of September 1st
Source: Adapted from (Government of Portugal, 2014)

For the development PMe this document presents the following methodology:

1. Identify the MSFD Environmental Goal
2. Check the existence of a measure already foreseen (implemented, not fully implemented or yet to be implemented) in legislative instruments, such as Water Framework Directive, Birds Directive, Habitats Directive, Common Fisheries Policy, commitments undertaken under international agreements or conventions or other instruments - Existing measure;
3. Analyze whether the existing measure is sufficient for the achievement of Environmental Goal MSFD;
4. Define additional measure, within the scope of the instruments referred to in point 2 or within the scope of the MSFD, in cases where the measure foreseen is not sufficient, for the achievement of the target, or there is no existing measure - New Measure;
5. Conduct impact assessment, including cost-benefit analysis and cost-effectiveness assessment, for the new measures

Applying the above methodology, existing measures were identified and, where necessary, new measures were established to meet the MSFD Environmental Goals - MSFD Measures.

For the purpose of setting the environmental goal of the MSFD, the Directive sets out a number of aspects to be considered for the establishment of the objectives, as set out below.

A. Adequate coverage of the elements characterizing marine waters

B. Need to be set:

1. goals establishing desired conditions based on the definition of good environmental status
2. measurable targets and associated indicators that allow for monitoring and assessment
3. operational targets relating to concrete implementation measures to support their achievement

C. Consistency of the set of goals; absence of conflicts between them

D. Specification of the resources needed for the achievement of goals

E. Formulation of targets, including possible interim targets, with a timescale for their achievement

F. Specification of indicators intended to monitor progress and guide management decisions with a view to achieving targets

G. Where appropriate, specification of reference points

H. Due consideration of social and economic concerns in the setting of targets

I. Examination of the set of environmental goals, associated indicators and limit and target reference points in order to assess whether the achievement of the targets would lead the marine waters falling under the sovereignty or jurisdiction of Member States within a marine region to a status matching them

J. Compatibility of goals with objectives to which the Community and its Member States have committed themselves under relevant international and regional agreements

K. When the set of targets and indicators has been assembled, they should be examined together relative to the environmental goals to assess whether the achievement of the targets would lead the marine environment to a status matching them

Source: Directive 2008/56/EC

The PMe also includes a number of measures, referred to as "other measures", which are not directly linked to the environmental objectives of the MSFD, but which are considered relevant to maintaining and achieving good environmental status of the marine environment in accordance with MSFD.

Finally, the PMe includes Spatial Protection Measures. These measures contribute to the establishment of a coherent and representative network of Marine Protected Areas (MPAs) in accordance with Article 13(4) of the MSFD.

Table 25 shows the marine pollution measures defined for the sub-division of Madeira Islands.

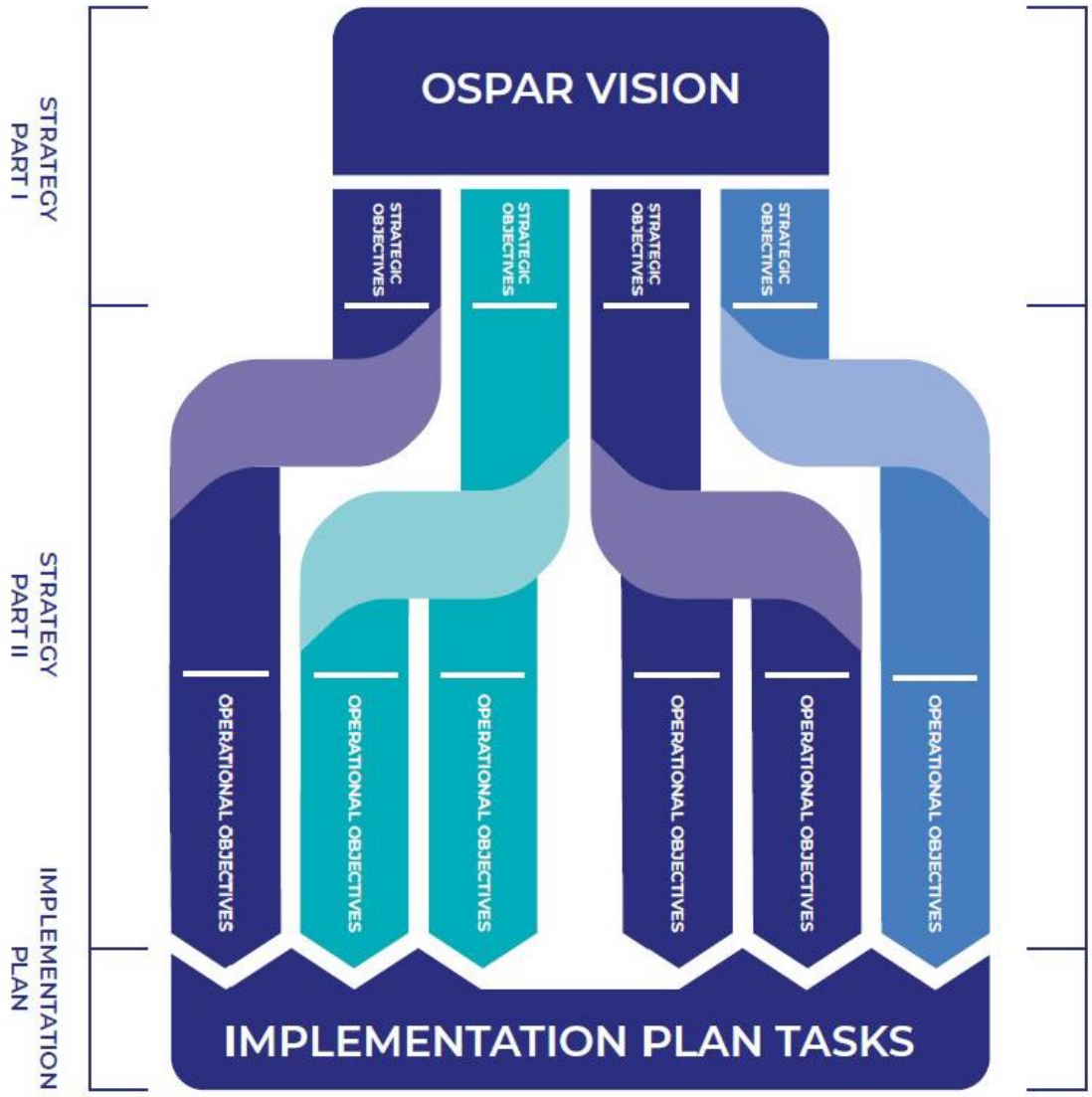
Table 25 - Marine pollution measures for Madeira Islands

Descriptor	Measure	Goal
MSFD Measure		
Marine Litter	LiMar - Determine bioindicators for marine litter	Choosing bioindicators for Portuguese marine waters
	DQEMsat - Implement the use of satellite images of the marine environment	Acquire knowledge of the marine environment
	VEGAS - Assess the potential of the Selvagens islands	Assess the potential of the Selvagens Islands as a prime location for monitoring marine debris in the Atlantic and how it is transported by currents.
Other Measure		
Contaminants in the marine environment	TOXIMAC - Establish an initial baseline status and indicators that should be monitored	Identify, monitor, analyze the effects and possible solutions of the presence of anthropogenic contaminants and microcontaminants (including emerging contaminants) in Macaronesian marine ecosystems
Marine Litter	EduMar - Educate and raise awareness about the marine environment	Increase literacy about the value of marine ecosystems

Source: (Governo de Portugal, 2014)

3.3.6. OSPAR Coordinated Environmental Monitoring Programme

OSPAR's vision is a clean, healthy and biologically diverse Northeast Atlantic Ocean that is productive, sustainably managed and resilient to climate change and ocean acidification. Its strategy sets out strategic and operational objectives to prevent marine pollution using an ecosystem approach (Figure 39). The application of the ecosystem approach requires monitoring, assessment and adaptive management.

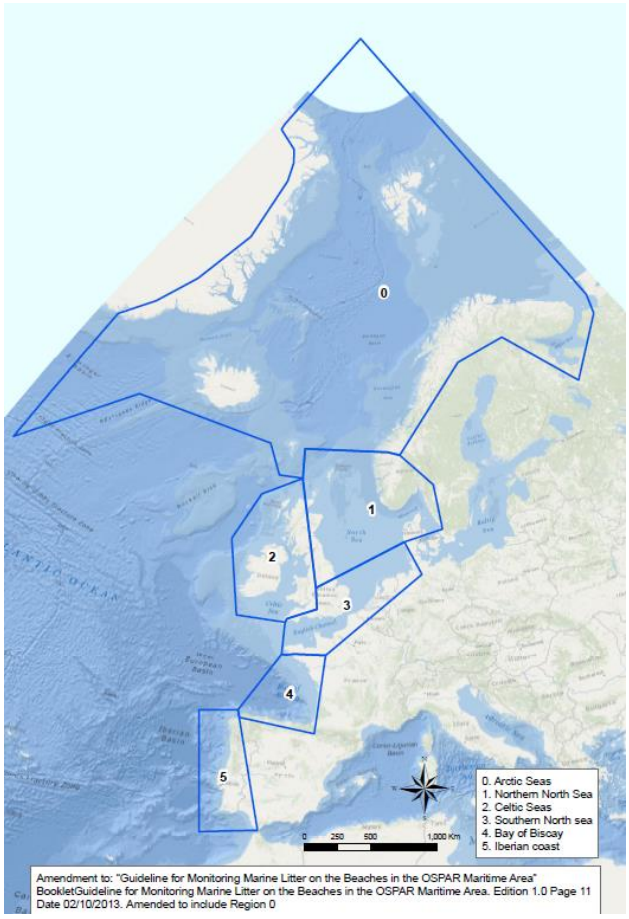


Source: (OSPAR Commission, 2021)

Figure 39 – Structure of Strategy of the OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic 2030

Therefore, the Coordinated Environmental Monitoring Programme (CEMP), a component of OSPAR's monitoring and assessment activities, is the mechanism through which the OSPAR's Contracting Parties have sought to coordinate the implementation of monitoring, data collection and assessment activities. The Joint Assessment & Monitoring Programme (JAMP) describes the strategy, themes and products that Parties are committed to deliver, through collaborative efforts, over period 2014-2023, encompassing the ecosystem approach and cross-cutting issues.

In this way, the CEMP makes it possible to provide the whole of the OSPAR Maritime Area (Figure 40) with comparable data and to use these data to develop coherent assessments that address the specific issues raised in the JAMP.



Source: (OSPAR Commission, 2010)

Figure 40 - Geographical scope of the OSPAR Maritime Area

The scope of the CEMP covers a wide range of pressures, marine ecosystem condition indicators and assessment approaches. As a result, the overall programme is flexible enough to accommodate both the specifics of the many issues at hand and practical considerations.

The programme includes monitoring data derived from direct measurements, as well as monitoring data derived through modelling and/or parameter aggregation, and regularly collects data and information from other organizations for use in OSPAR assessments.

The CEMP is divided into six themes, reflecting the different issues addressed by OSPAR under its thematic objectives. Each theme consists of a number of components,

for which the CEMP provides details of the agreed approaches to monitoring and assessment, including the approaches to be used to achieve coordination of monitoring and assessment.

Table 26 - CEMP Thematic Aspects

Theme	Thematic Objective
Theme A: Cross cutting Components	• Monitoring and assessment related to ocean acidification
Theme B: Biodiversity and Ecosystems	• Biodiversity and ecosystem monitoring and assessment • Human activity and pressure monitoring and assessment
Theme E: Eutrophication	• Eutrophication monitoring and assessment
Theme H: Hazardous Substances	• Contaminants and their biological effects monitoring and assessment.
Theme O: Offshore Oil and Gas Industry	• Monitoring and assessment related to the offshore oil and gas industry, focused on produced water from offshore installations
Theme R: Radioactive Substances	• Environmental and pressure data and assessments related to radioactive substances

Source: adapted from (OSPAR Commission, 2016)

For a CEMP component to be fully realised, the following coordinating tools need to be in place to ensure coordinated monitoring and evaluation:

- Monitoring and/or data collection guidelines;
- Coordinated arrangements for data submission and management;
- Quality assurance tools;
- Assessment criteria and, where relevant, procedures for aggregation or integration of data prior to assessment

Several CEMP monitoring guidelines have been developed and published on the OSPAR website, providing detailed documentation of agreed monitoring, quality assurance tools and assessment methods. Table 27 presents CEMP guidelines relevant for marine pollution.

Table 27 - CEMP Guidelines relevant for marine pollution

Guideline	Pollution Sources	Pollution Issues
CEMP Guidelines for the assessment of dumping and placement of waste or other matter at sea	• Marine-based - Fisheries and aquaculture - Dredging	• Waste
CEMP Guidelines on Litter on the Seafloor	• Marine-based - Shipping - Fisheries and aquaculture • Land-based - Sewage treatment plans - Urban areas - Harbours & Ports - Tourism activities - Industry - Agriculture	• Litter and microplastics
CEMP Guidelines for Monitoring and Assessment of beach litter		
CEMP Guidelines for Monitoring and Assessment of marine litter ingested by sea turtles		
CEMP Guideline on the analysis of PFASs in Seawater (Agreement 2010-08)	• Industry • Urban	• Hazardous substances
CEMP Guidelines for coordinated monitoring for hazardous substances	• Industry • Urban	• Hazardous substances
CEMP guidelines for coordinated monitoring for eutrophication, CAMP and RID	• Sewage treatment plants • Industry • Urban • Agriculture	• Nutrients
Revised JAMP Eutrophication Monitoring Guideline: Nutrients		
JAMP Guidelines for Monitoring Chemical Aspects of Ocean Acidification	• Industry • Urban	• Acidification

Source: (OSPAR Commission, 2016)

3.3.7. Regional Action Plan on Marine Litter Management (RAPMaLi) for the Wider Caribbean Region

RAPMaLi (UNEP/CEP, 2014) aims to provide a comprehensive toolkit to aid SIDS in implementing effective waste management practices across all sectors. It proposes a series of preventive and reactive actions at the national and regional levels for marine litter management in the Caribbean under the following themes (Table 28: (i) Legislation, Policies and Enforcement; (ii) Institutional Framework and Stakeholder Involvement; (iii); Monitoring Programmes and Research; (iv) Education and Outreach; (v) Solid Waste Management.

Table 28 - List of actions for marine litter management in RAPMaLi

Action categories	Description / actions
Legislation, Policies and Enforcement	National regulations and policies should address solid waste management and other pollution concerns; enforcement and penalties are important, a sense of environmental stewardship by everyone and not only ocean users are essential for laws to be effective.
	Actions: • Evaluate existing legislation, regulations and enforcement practices that deal with marine litter and strengthen or enact new legislation/regulations as appropriate. • Establish and/or enhance government sponsored "litter wardens or patrols" in coordination/collaboration with municipal police/security forces and establish the infrastructure for compliance. • Implementation of the 2012 Revised MARPOL Annex V and Special Area status for the Wider Caribbean Region • Expand ratification and promote effective implementation of MARPOL Annex V and LBS Protocol of the Cartagena Convention by all Caribbean states. • Ensure that debris and ecosystem health issues are integrated into emergency management plans and procedures. • Establish a clearinghouse of information on effective strategies and practices for enforcement of waste management practices. • Mobilize resources for improving the capacity for enforcement of appropriate integrated waste management practices.

Action categories	Description / actions
Institutional Frameworks and Stakeholder Engagement	Linkages between government agencies and the private sector should be made stronger to improve efficiency in the management of marine litter.
	Actions: • Develop and implement a model of a national management plan for marine litter. • Establish the infrastructure for compliance with existing marine litter management legislation at the national and community levels. • Establish a Caribbean Marine Litter Regional Working Group to coordinate and advise on appropriate actions for marine litter management. • Provide training for judiciary/magistrates/ enforcement officers and sensitization of politicians on marine litter issues. • Present information on the marine litter issue at key environmental meetings & conferences in the Region.
Monitoring Programmes and Research	Monitoring programme can support an expanded understanding of the problem and function as an ongoing component of management strategies that deal with pollution by marine litter.
	Actions: • Design and implement a strategy to develop national marine litter monitoring pilot projects in the WCR, including standardised methods for data collection and reporting within the framework of the UNEP Regional Seas Global Marine Litter Monitoring Guidelines. • Develop a regional, web-based database as a clearinghouse for marine litter information and research. • Engage all stakeholders at community (local), national and regional levels in monitoring and research efforts. • Solicit information/research from fisheries, wildlife, and other resource management agencies and programmes throughout the region on the environmental and economic impacts of marine litter on wildlife and ecosystems. • Conduct an assessment of the economic impacts of marine litter, including costs for clean-up efforts, maintenance of recreational beach areas, costs for lost or abandoned fishing gear and the costs associated with loss of recreational uses of impacted coastal areas. • Conduct a GAP analysis of overlap of high density marine litter areas with areas of high sensitivity (endangered species, key habitats, etc.) in order to prioritise clean- up and mitigation efforts.

Action categories	Description / actions
	• Review and disseminate research on the identification, removal and disposal of marine litter to enable more effective recovery efforts and disposal of marine litter.
Education & Outreach	An effective strategy to help groups address this pervasive issue through outreach and education activities will be implemented through a variety of venues, including radio and television public service announcements (PSAs), web-accessible materials, use of social media, and printed educational materials (brochures, posters) that can be used by government agencies, NGOs, and business and industry groups.
	Actions: • Develop and implement community-based public education campaigns for marine litter prevention, including specialised marine litter prevention programmes for key user-groups and stakeholders. • Develop a regional campaign for the International Coastal Cleanup. • Incorporate cultural concepts, including use of popular culture icons in outreach programming to promote behavioural change. • Incorporate marine litter issues into other community calendar and environmental events. • Integrate issues of marine litter into formal educational curricula and programming. • Collate best management practices, case studies and lessons learnt on marine litter management at the community and national levels and communicate these with UNEP CAR/RCU for regional compilation and dissemination.
Solid Waste Management Strategies	Integrate marine litter management strategies into existing and/or proposed national solid waste management strategies through efforts to coordinate programme activities, waste management policies and resources.
	Actions: • Maintain/develop specialised marine litter waste management strategies for public events (either as a separate strategy or part of an existing waste management strategy). • Research BMP's for waste management practices in the hotel, restaurant and marine transport industries and strengthen collaboration with the tourism sector for sharing of best practices and lessons learned.

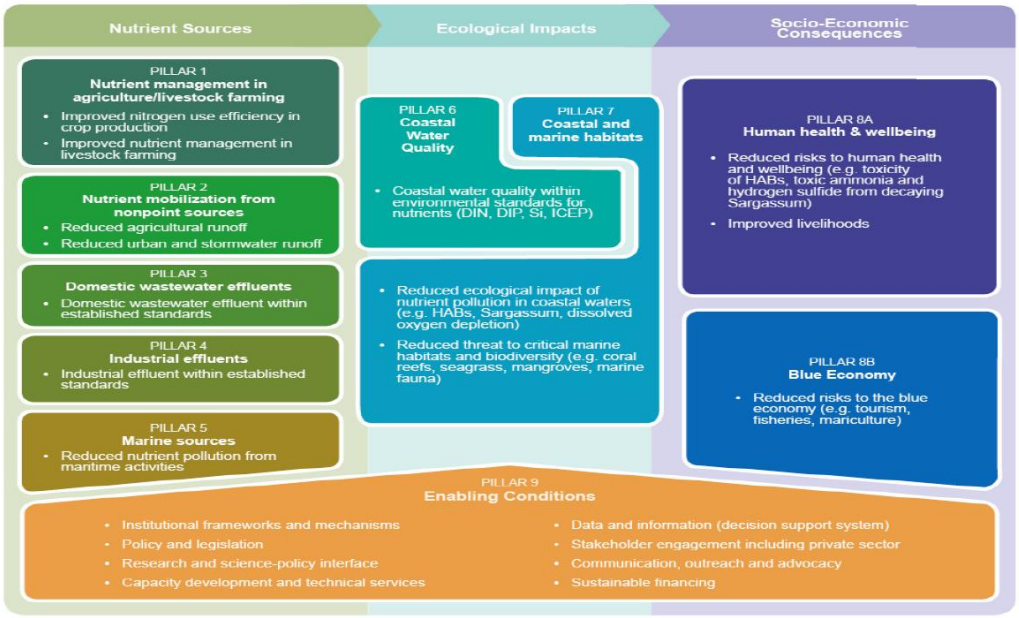
Action categories	Description / actions
	• Develop and promote activities for national/regional waste minimisation. • Identify/promote international environmental certification programmes which include waste management and minimisation. • Maintain/develop specialised waste management strategies for marine litter problems associated with natural disasters. • Improve Port Reception Facilities to effectively manage ship generated waste.

Source: adapted from (UNEP/CEP, 2014)

3.3.8. Regional Nutrient Pollution Reduction Strategy and Action Plan for the Wider Caribbean Region

The purpose of this document (UNEP/CEP, 2021) is to provide a collaborative framework for progressively reducing the impact of excess nutrient loads on priority coastal and marine ecosystems in the Wider Caribbean Region (WCR). At its core are nine pillars, each of which has its own objectives and corresponding benchmarks and indicators. Eight (8) of the nine (9) pillars cover the full range of the nutrient challenge, from significant point and non-point sources to impacts on coastal waters and socio-economic impacts due to nutrient pollution of the marine environment. Pillar 9 addresses the enabling environment required for the implementation of the WCR Regional Nutrient Pollution Reduction Strategy and Action Plan (RNPRSAP). (Figure 41).

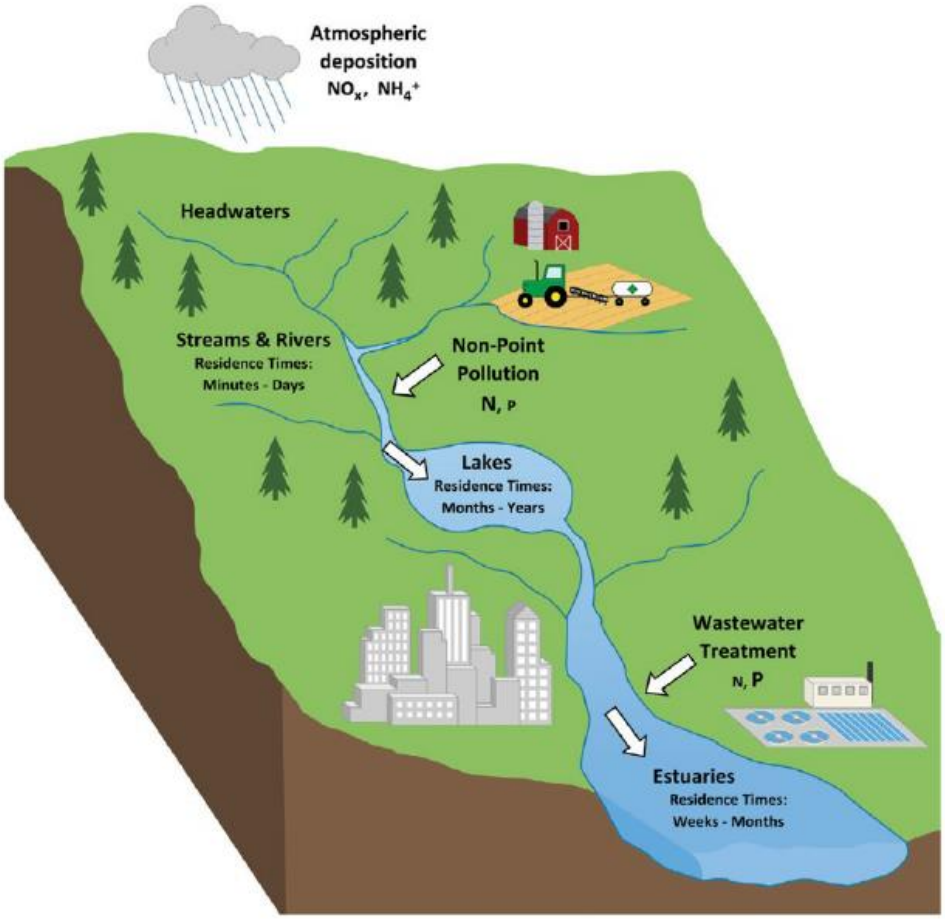
The RNPRSAP addresses the major land- and sea-based sources of nutrient pollution in the Wider Caribbean Sea, in line with the scope of the Cartagena Convention for the Protection of the Marine Environment of the Wider Caribbean Region and its Protocol on land-based sources of marine pollution. These sources include agriculture, domestic and industrial wastewater, and wastewater from maritime activities (cruise ships, recreational craft and cargo ships).



Source: (UNEP/CEP, 2021)

Figure 41 – Structure of the WCR nutrient pollution reduction strategy showing the nine Pillars and associated objectives

The RNPRSAP is holistic in its approach, recognizing the links between upstream and downstream and between terrestrial, freshwater (surface and groundwater) and coastal marine waters, both surface and subsurface. In the RNPRSAP approach considers catchments as the geographical management unit on the terrestrial side, and also includes major marine sources of nutrient pollution from sectors such as cruise tourism and shipping (Figure 42). For larger countries (continental countries and large islands) this approach considers individual watersheds, whereas for small islands the whole landmass is considered as a watershed.



Source: (UNEP/CEP, 2021)

Figure 42 – Watershed Management Unit of WCR NPRSAP approach

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Table 29 - WCR NPRSAP Strategic Framework

Strategic Component	Description
Overall Goal	• To establish a collaborative framework for the progressive reduction of impacts from excess nutrient loads on priority coastal and marine ecosystems in the WCR.
Objectives	• Overall
	• To assist in defining regional standards and criteria for nutrient discharges including regional indicators for monitoring those discharges to the coastal and marine environment; • To support institutional, policy and legal reforms relating to nutrients and sediments management including supporting integrated, high-priority interventions to reduce discharge of untreated sewage, nutrients and sediments, agrochemical run-off and promote recovery of nutrients from wastewater; • To contribute to relevant regional and global commitments including United Nations Environment Assembly (UNEA) Resolution 4/14 on Sustainable Nitrogen Management, UNEA Resolutions on Marine Pollution, the Cartagena Convention for the Protection of the Marine Environment of the Wider Caribbean region and its Protocol on Land-Based sources of Marine Pollution, and Sustainable Development Goals (SDG) 6 and 14; • To contribute to the operationalization of the Caribbean Platform for Nutrient Management under the aegis of the GPNM; • Contribute to the UN Global Campaign on Sustainable Nitrogen Management.
	• Specific
	• To identify high priority areas for further action based on most affected ecosystem types and most important socio-economic impacts; • To assist in defining new areas of research relating to nutrient pollution in the Wider Caribbean Region; • To assist in establishing the pollution baseline and informing the development of national and/or regional projects including those funded by the Global Environment Fund (GEF); • To facilitate building in-country capacity to access funding to implement best practices/interventions for nutrient reduction; • To contribute to the operationalization of the Caribbean Platform for Nutrients Management;

Strategic Component	Description
Objectives	• To facilitate knowledge exchange and transfer on best practices and case studies relating to nutrients and sediments management including South-South cooperation and GEF International Waters (IW) Learn; • To contribute to leveraging of additional financing for on-ground investment in best practices to reduce the influx of land-based nutrient pollution to the Caribbean Large Marine and North Brazil Shelf Ecosystems; • To expand the baseline developed under the State of Convention Area (Pollution) Report and identify most important "regionally relevant" pollution sources in terms of the transboundary nature of both sources and impacts.
Guiding principles	• Science-based approach, using the best available science, data and information, and incorporating local/traditional knowledge; • Building on the existing foundation established by regional and global initiatives; • A ridge to reef, integrated watershed approach that considers nutrient sources in watersheds to their impacts in coastal waters, and the heterogeneity among the WCR countries and territories in terms of biogeophysical characteristics and sectors contributing to nutrient pollution; • Balancing ecological, social, and economic imperatives in decision-making throughout the upstream-downstream continuum; • Alignment of objectives and targets with relevant national, regional and global policies, frameworks and targets to achieve multiple benefits; • Strategic, preventative actions at source that are feasible and cost-effective; • Engagement of all key stakeholders including private sector within a multiscale governance framework that encompasses all policy cycle stages;

Strategic Component	Description
Target audience	• Parties to the Cartagena Convention and LBS Protocol • Other WCR Governments • Regional Seas Programme • Sub-regional political groupings: Caribbean Community (CARICOM), Organization of Eastern Caribbean States (OECS), Central American Integration System/Commission for Environment and Development (SICA/CCAD) • Amazon Cooperation Treaty Organization (ACTO) • Research and academic • United Nations Environment Programme (UNEP); other UN and Intergovernmental Organizations (IGO) • Donor agencies • Private sector, including farmers • Non-Governmental Organizations • General public and local communities

Source: adapted from (UNEP/CEP, 2021)

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An institutional framework and an action framework are proposed for the implementation of the NPRSAP. With the support of international, regional and sub-regional organizations and partners, implementation will be gradual and mainly through national initiatives.

The multi-level institutional framework required to implement the WCR NPRSAP will involve stakeholders representing all levels of the cycle at all levels, from local/national to sub-regional and regional to global, as shown in Table 30.

Table 30 - Multi-level institutional framework

Level	Stakeholders
Global	• UNEP, Food and Agriculture Organization (FAO), IMO, Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA), GPNM, United Nations Development Programme (UNDP), Pan American Health Organization (PAHO), and World Health Organization (WHO).
Regional	• UNEP CAR/RCU Cartagena Convention Secretariat (responsible for coordinating the implementation of the RNPRSAP supported by the LBS Regional Activity Centres (RACs) and Regional Activity Network (RAN), LBS Protocol STAC and Monitoring and Assessment Working Group), GPNM-Caribbean.
Sub-regional	• CARICOM, SICA/CCAD, OECS, and ACTO - Support implementation of the strategy among member states, by integrating the strategy and action plan into their relevant programmes; and facilitating stakeholder engagement and awareness raising.
National	• Cartagena Convention and LBS Protocol Contracting Parties and non-contracting countries) will be responsible for implementing the required actions at the national and local levels. This will involve creating the enabling conditions at the national level. Increased ratification of the Convention and Protocol will greatly contribute to achieving the objectives of the strategy.
Partnerships	• Partnerships with technical and programmatic stakeholders from civil society, the private sector and academia, among others, and engagement with financial institutions will be critical to support roll out of the strategy and action plan.

Source: adapted from (UNEP/CEP, 2021)

The action framework for the implementation of the RNPRSAP consists of activities at regional, sub-regional and national levels that are required to achieve the objectives and targets of the strategy, and must therefore identify and prioritise targeted and quantifiable actions to ensure that limited resources are allocated where needs are identified.

LINE OF ACTION/ MILESTONE	ACTIVITIES	INDICATIVE TIMEFRAME
REGIONAL LEVEL (UNEP CAR/RCU, Cartagena Convention Secretariat)		
Adoption of the RNPRSAP	• Review of the RNPRSAP by the LBS STAC and adoption by the LBS COP • Develop a M & E framework to track and assess progress in implementation of the strategy.	2021
Policy and institutional framework	• Promote ratification of the Convention and LBS Protocol among non-member countries. • Recommend and facilitate necessary amendments to the LBS Protocol to explicitly cover nutrients and links between the state of the Convention Area coastal waters with upstream sector activities and practices. This may include consideration of a new Annex dedicated to Nutrients. • Facilitate operationalization of GPNM-Caribbean. • Identify opportunities for strengthening the LBS M & E Working Group and LBS RACs for nutrient management. • Facilitate coordination in implementation of the RNPRSAP and Habitats Strategy by member states. • Establish/strengthen strategic partnerships with regional and international organizations, academic institutions, among others, including through the CLME+ partnership arrangement. • Collaborate with the IMO to strengthen mechanisms to address nutrient pollution from marine sources. • Engage with sub-regional political integration mechanisms (CARICOM, OECS, SICA/CCAD) and ACTO to mainstream management of nutrient pollution in their respective programmes and to support downscaling and implementation of the RNPRSAP in member states (through the CLME+ Interim Coordination Mechanism/long-term Coordination Mechanism). • Strengthen the multi-level regional governance framework.	2021-2025 2021-2025 2021-2025 2021-2025 2021-2030 2021-2025 2021-2025 2021-2025 2021-2025

Source: (UNEP/CEP, 2021)

Figure 43 – Example of proposed activities at the regional level of the Action Framework

Table 31 - Proposed activities at the national level of the Action Framework

Action	Activities	Timeframe
Institutional framework / mechanisms	Designate an appropriate agency or mechanism to coordinate activities for the integrated management of nutrients using a watershed, ridge to reef approach.	2021-2025
	Support the establishment of or strengthen existing national inter-sectoral or inter-ministerial committees to address nutrient pollution.	2021-2025
	Review existing institutional framework to identify gaps and weaknesses related to nutrient management.	2021-2025
	Initiate process of reform and harmonization to ensure an appropriate institutional framework for nutrient management. This should include an intersectoral body, public-private partnerships, etc. and facilitate local/national/regional linkages.	2021-2025
	For transboundary watersheds and groundwater aquifers, establish and operationalize a framework for cooperation among the concerned states.	2025-2030
Management of transboundary river basins and groundwater aquifers	Establish or strengthen agreement and mechanism of cooperation for transboundary (shared) river basins and groundwater aquifers.	2025-2030
	Develop 'Common River Basin Management Plans' between the relevant countries.	2025-2030
Stakeholder engagement and communication/ public awareness	Identify key stakeholders at national and local levels and develop/implement a strategy for stakeholder engagement and awareness campaign on nutrients, linked to regional strategy; elevate the nutrient issue on the national agenda.	2021-2025
	Enhance mechanisms for communication among relevant sectors and between watershed scientists and policy-makers (consider establishing an intersectoral mechanism that is linked to the sub-regional/regional level).	2021-2025
	Establish strategic partnerships including public-private partnerships.	2021-2030

Action	Activities	Timeframe
Policy, legislation, and regulatory frameworks	Review policy and legislative frameworks to identify gaps, weaknesses and barriers to effective implementation of the strategy.	2021-2025
	Accede to and implement the Cartagena Convention and LBS Protocol (as appropriate).	2021-2025
	Mainstream the RNPRSAP into national planning and development frameworks; initiate process of reform and harmonization to ensure a coherent policy and legislative framework that links downstream water quality with upstream practices in the domestic wastewater, agriculture, and industrial sectors; and promotes compliance with national guidelines, standards and limits.	2021-2030
	Establish nitrogen (N) and phosphorus (P) standards and limits for domestic and industrial effluent, and water quality for designated uses.	2025-2030
	Mainstream nutrient management goals and targets into policy and legislation.	2025-2030
	Strengthen mechanisms for compensation to affected persons for losses, and for compliance and enforcement.	2025-2030
	Strengthen implementation of Multilateral Environmental Agreements (MEA) and other commitments that are relevant to nutrient management.	2021-2030
Characterize and prioritize watersheds	Identify priority watersheds that individually or collectively account for a substantial portion of nutrient loads (e.g., more than 75%). Criteria to be determined by the countries.	2021-2025
	Identify major sources of nutrient loads in priority watersheds (e.g., domestic wastewater, agriculture/livestock, industries).	2021-2025
	Collect baseline data in priority watersheds including land use, fertilizer use, nitrogen use efficiency, N and P sources and magnitude, environmental impacts, socio-economics, etc.	2021-2025
	Downscale and validate models: Use best available information to estimate N and P loadings delivered to aquatic systems from each major source/sector in all major watersheds.	2021-2025

Action	Activities	Timeframe
Screen and classify coastal waters	Determine the eutrophication status of coastal areas.	2021-2025
	Identify coastal nutrient hotspots and associated major sources of excess nutrients.	2021-2025
	Classify receiving waters in accordance with the obligations of the LBS Protocol (Class 1 and Class 2 of equivalent classification system).	2021-2025
Monitoring, data collection, assessment and reporting	Based on the above screening and classification, develop or strengthen existing monitoring programmes for the different classes and eutrophication status of identified areas. Monitoring should include N, P and Si sources and magnitudes, estimation of Index of Coastal Eutrophication Potential (ICEP), environmental impacts, socio-economic data, etc. using indicators that are harmonized with regional and global indicators. Monitoring should include citizen science, and traditional and modern approaches.	2025-2030
	Develop national data management system linked to a regional data management system.	2025-2030
	Develop or strengthen mechanism for periodic assessment and reporting and informing adaptive management, policy responses and decision-making. This should include preparation of knowledge products such as report cards.	2025-2030
Capacity building	Assess capacity gaps at local and national levels and across all relevant disciplines.	2021-2025
	Develop and implement capacity building programmes to address identified gaps, including technical assistance for farmers and agricultural extension officers and those involved in the health, water and wastewater sectors, and estimation of ICEP.	2021-2025
	Identify opportunities for learning and sharing of experiences with other countries.	2021-2030
	Promote use of available resources (GEF-GNC Global Nutrient Management Toolbox, UNEP-CEP technical reports on best management practices for wastewater and erosion, US nutrient reduction strategies and action plans- Gulf of Mexico states)	2021-2030

Action	Activities	Timeframe
Incentive programmes	Develop incentive programmes for farmers and other sectors (to promote nutrient management, wastewater treatment and treated wastewater reuse). This should include assessing economic policy instruments for financial incentives and identifying opportunities for recovery and reuse of nutrients, increasing production and income generation for farmers (e.g., from cover crops), payment to farmers and landowners for ecosystem services.	2025-2030
Financial resources	Develop a sustainable financing plan and identify funding sources and opportunities (Public sector financing, private sector investment, development banks, international donors and mechanisms including GEF Small Grants Programme, trust funds, fiscal measures such taxes, market-based financing mechanisms, etc.) for implementation of nutrient management programme.	2025-2030
Scientific research	Identify policy-relevant research priorities and facilitate the conduct of research including through partnerships with academic institutions and creation of opportunities for scientists. See the Caribbean Large Marine Ecosystem (CLME+) Pollution Research Agenda.	2021-2025
	Strengthen the science-policy interface to facilitate uptake of science in policy setting.	2021-2030
Nutrient reduction targets and allocation of allowable pollution loads	Establish quantitative nutrient reduction targets by source in each priority watershed in accordance with waterbody designated uses and to protect/ improve ecosystem services.	2025-2030
	Estimate current nitrogen use efficiency (NUE) and determine required reduction to achieve NUE targets.	2021-2025
	Identify and evaluate management practices (see the GNC database) to achieve the reduction targets and loads.	2021-2025
	Allocate the allowable pollution loads to the various sources.	2025-2030
National nutrient pollution reduction strategy and	In consultation with all key stakeholders and based on the RNPRSAP, develop a national nutrient pollution reduction strategy and action plan(s) for priority watersheds to achieve the reduction targets as well as other targets identified, appropriate mix of BMPs*, cost-benefit analysis of BMPs based on the local context, financial mechanism and incentives, Monitoring and Evalutation plan, strategy	2021-2030

Action	Activities	Timeframe
national/watershed action plans	for dissemination of lessons, replication and upscaling, etc. National strategy and action plan should be aligned with national 2030 Sustainable Development Agendas and incorporate consideration of climate change impacts on sediment and nutrient mobilization, and crop production.	
	Implementation of the programme could be incremental, starting with the highest priority watershed(s) and hotspots. As far as possible, implementation should be coordinated with that of the Regional Habitats Strategy to multiply benefits.	2021-2030
	*Innovative and market-based management practices should be identified. A range of practices beyond the traditional point and nonpoint source management practices can be used to reduce nutrient loads. These include programmes for engaging industries, businesses, and agricultural enterprises for voluntary pollution prevention; regulations for emission of nitrogen gases; basin or watershed-based nutrient trading programmes; and water and input management practices.	2021-2030
Implement watershed action plan(s)	Implement action plan(s) for priority watershed(s) 2025 -2030	2025-2030
Port reception facilities	Establish/improve port reception and treatment facilities for wastewater from ships.	2025-2030
Monitoring and adaptive management	At regular intervals, monitor and evaluate progress towards achievement of targets using established indicators (process, stress reduction, socio-economic and environmental state indicators) and impacts of the implemented solutions. This will include reporting every two years by Member States to the LBS Protocol Conference of Parties	2030 and beyond
	Adapt management actions based on results and incorporating any new scientific data and information, and emerging issues.	
	Document and communicate results and lessons.	

Source: adapted from (UNEP/CEP, 2021)

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Finally, it provides a framework for monitoring and evaluating the effectiveness of nutrient pollution control measures and a compilation of best management practices (BMP). This framework proposes for each objective global targets, regional targets and indicators, as shown in Table 32.

Table 32 - Monitoring Framework: Indicators

Action categories	Objectives/Indicators
Pillar 1: Nutrient management in agriculture/livestock farming	Objective 1.1. Improved nitrogen use efficiency in crop production Objective 1.2. Improved nutrient management in livestock farming
	• Fertilizer application rate (weight/ha) by crop type • Partial Nutrient Balance (kg nutrient removed/kg nutrient applied) and Partial Factor Productivity (t yield/kg nutrient applied). • Fertilizer imports - weight/yr • Sub-indicator of SDG 2.4.1: Proportion of agricultural area under productive and sustainable agriculture. • Sustainable Nitrogen Management Index • No. best management practices (BMP) installed/no. farms; No. farms /area under BMPs • Production-based nitrogen emissions kg/capita • Nitrogen use efficiency • Crop yield, income, costs
Pillar 2: Nutrient mobilization from nonpoint sources	Objective 2.1. Reduced agricultural runoff
	• Production-based nitrogen emissions kg/capita • Fertilizer application rate (weight/ha) by crop type • Partial Nutrient Balance (kg nutrient removed/kg nutrient applied) and Partial Factor Productivity (t yield/kg nutrient applied) • Fertilizer imports - weight/yr • SDG Sub-indicator of 2.4.1: Prevalence of soil degradation • SDG Indicator: 15.2.1: Progress towards sustainable forest management (preventing erosion and loss of nutrients) • SDG Indicator 15.1.1: Forest area as a proportion of total area • SDG Indicator 15.3.1: Proportion of land that is degraded over total land area • Trends in land cover • Trends in land productivity or functioning of the land • Trends in carbon stocks above and below ground • Proportion of water with good ambient water quality • Nitrogen balance • Phosphate balance • Fertilizer use

Action categories	Objectives/Indicators
	• Trends in Loss of Reactive Nitrogen to the Environment
	Objective 2.2. Reduced urban/stormwater runoff to coastal areas
	• Proportion of municipal solid waste collected and managed in controlled facilities out of total municipal waste generated, by cities. • Annual mean levels of fine particulate matter in cities.
Pillar 3: Domestic wastewater effluents	Objective 3.1. Domestic wastewater within established effluent standards
	• % discharge compliant with N and P effluent standards for domestic wastewater, by municipal and industrial source. • N and P loads and concentrations in wastewater effluent. • SDG 6.3.1. Volume of anthropogenic wastewater that receives treatment (safely treated) • N and P levels in wastewater effluent • % effluent by volume compliant with effluent standards for domestic wastewater • % wastewater flows treated to national standards • Volume of TSS discharged in domestic wastewater.
Pillar 4: Industrial effluent	Objective 4.1. Industrial effluent within established standards for nutrients
	• Proportion of domestic and industrial wastewater flows safely treated. • Proportion of bodies of water with good ambient water quality. • SDG Indicator 12.5.1. National recycling rate, tons of material recycled • Proxy indicator of 12.5.1. Proportion of recycled waste in relation to total collected waste • Volume of industrial effluent treated before discharge/yr • N and P concentration and loads in industrial discharge
Pillar 5: Marine sources	Objective 5.1. Reduced nutrient pollution from maritime activities
	• To be established (similarities with domestic wastewater)

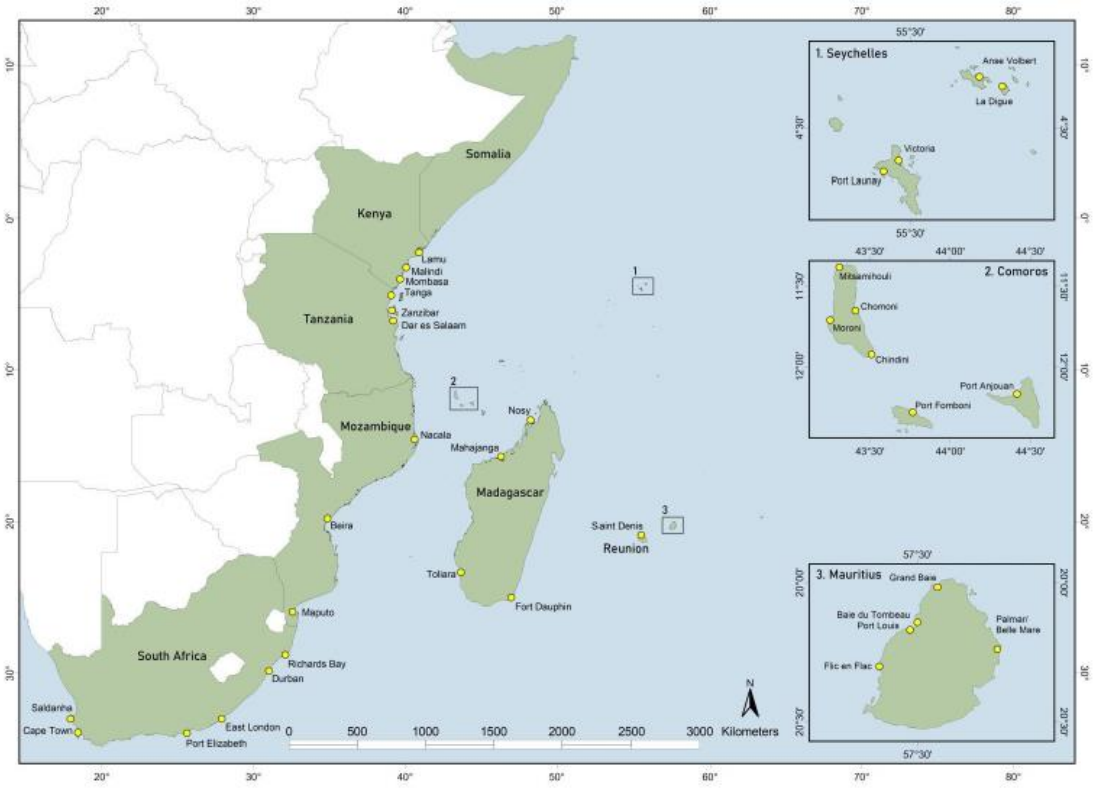
Action categories	Objectives/Indicators
Pillar 6: Coastal water quality	Objective 6.1. Coastal water quality within environmental standards for nutrients
	• Dissolved Inorganic Nitrogen (DIN) • Dissolved Inorganic Phosphorus (DIP) • Chlorophyll a (Chl-a) • Dissolved Oxygen (DO) (bottom waters) • Turbidity/Suspended solids • Water transparency/Secchi disc depth • Indicator 14.1.1: (a) Index of coastal eutrophication potential (ICEP); and (b) % Chl-a deviations • Proportion (%) of bodies of water (rivers, groundwater and coastal waters) with good ambient water quality
Pillar 7: Healthy coastal and marine habitats	Objective 7.1. Reduced ecological impact of nutrient pollution in coastal waters Objective 7.2. Reduced threat to critical marine habitats and biodiversity from nutrients
	• Areal extent of Sargassum in the ocean; • Weight of Sargassum removed from beaches; • No. and extent of algal blooms/yr; • No. Harmful Algal Bloom (HAB) events/yr; • No. mass mortality events (fish kills)/yr; • Area and duration of hypoxic zone

Action categories	Objectives/Indicators
Pillar 8a: Human health and wellbeing	Objective 8.1. Reduce risks to human health and wellbeing from nutrient pollution
	• SDG Indicator 3.9.2. Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene • SDG Indicator 3.9.3 Mortality rate attributed to unintentional poisoning • Number of persons affected and type of illnesses per year • Number of advisories for polluted water per year • Number of shellfish beds and fisheries closures per year • Annual health care costs associated with nutrient pollution impacts
	Objective 8.2. Improved livelihoods
	• No. persons affected/yr • Loss/increase in income (US dollar)/yr • Number of new opportunities created (e.g., from reuse and recycling) • Number jobs created/number of beneficiaries
	Objective 8.3. Reduce risk to the blue economy from nutrient pollution
	• Economic losses/yr (US dollar) by sector • Job losses/yr by sector • Number of new opportunities/new industries created • Change in revenue (linked to reduced nutrient pollution) • Annual economic cost of mitigating nutrient pollution and addressing its impacts

Source: adapted from (UNEP/CEP, 2021)

3.3.9. Western Indian Ocean Strategic Framework for Coastal and Marine Water Quality Management

The document presents a strategic framework for the implementation of national coastal and marine water quality management in the 10 countries/territories which are Contracting Parties of the Nairobi Convention for the Protection, Management and Development of Coastal and Marine Environment of the Western Indian Ocean (WIO, Figure 44, Figure 45).



Source: (UNEP/Nairobi Convention Secretariat, CSIR, 2021b)

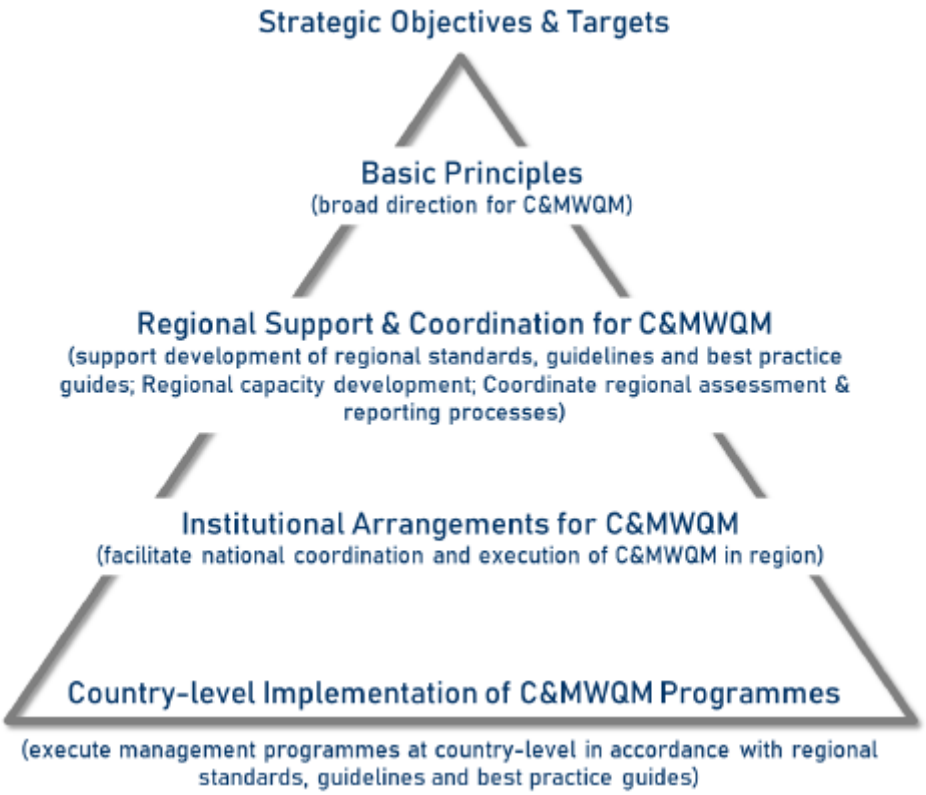
Figure 44 – Geographical scope of the Western Indian Ocean countries and territories (Reunion) and marine pollution hotspots (major costal urban cities)

COUNTRY	SIZE OF LAND AREA (km^2)	POPULATION ($x10^6$) (2019)	ESTIMATED % LIVING NEAR COAST (2000)		
			<25 km	<75 km	<100 km
Comoros	2,170	0.85	100	100	100
Kenya	582,650	52.57	6.1	7.5	8
Madagascar	587,040	25.67	23.2	45	55
Mauritius	2,040	1.27	100	100	100
Mozambique	801,590	30.37	32.7	52.1	59
Reunion	2,517	0.86	100	100	100
Seychelles	455	0.98	100	100	100
Somalia	637,657	15.44	30.5	52.7	55
South Africa	1,219,912	58.56	23.4	35.9	39
Tanzania	945,087	58.00	13.6	17.3	21

Source: (UNEP/Nairobi Convention Secretariat, CSIR, 2021b)

Figure 45 – General characteristics of the Western Indian Ocean countries and territories (Reunion)

The key elements of the Strategic Framework are presented in Figure 46 and Table 33.



Source: (UNEP/Nairobi Convention Secretariat; CSIR, 2021a)

Figure 46 – Conceptual elements of the Strategic Framework for Coastal and Marine Water Quality Management in the Western Indian Ocean Region

Table 33 – Main elements of the Strategic Framework for Coastal and Marine Water Quality Management in the Western Indian Ocean Region

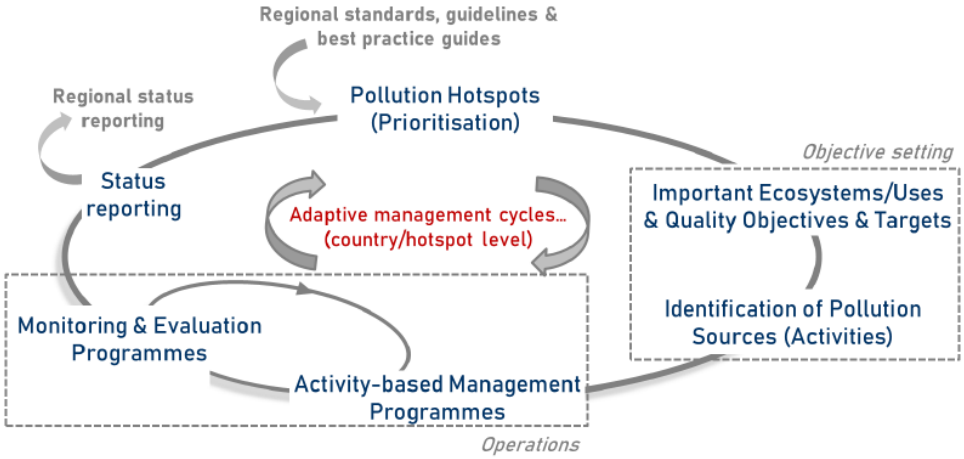
Element	Description
Strategic Objective	Water quality in the WIO region meets international standards by year 2035: • Quality of coastal and marine waters in the WIO region meet regionally agreed standards • Wastewater discharges adhere to agreed national and regional effluent standards • Increased government budget allocations for pollution prevention
Targets	From *Strategic Action Programme Protection of the Coastal and Marine Environment of the Western Indian Ocean from Land-based Sources and Activities* (SAP WIO-LaB, 2009): • Effluent discharge standards developed and regionally harmonized • Marine water standards developed and regionally harmonized (Guidelines for the development of Environmental Quality Objectives and Targets) • Regional best practice framework models for municipal wastewater management developed and adopted • Collection, treatment and disposal of effluents undertaken in accordance with regional standards • Environmental management systems and cleaner production technologies encouraged • Stakeholders' sensitized and political support harnessed in favour of pollution prevention • From *Strategic Action Programme for the Sustainable Management of the Western Indian Ocean Large Marine Ecosystems* (SAP WIO-LME, 2014): • 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

Element	Description
Basic Principles	• Principle 1: Pollution prevention, waste minimisation and precautionary approach: a hierarchy of decision-making applies in management of potential coastal and marine pollution sources (align with circular economy) • Principle 2: Receiving water quality objectives approach: requirements of the aquatic ecosystem, as well as requirements of other beneficial uses of resources, determine the limits to be met in pollution sources (unlike a uniform effluent standard approach) • Principle 3: Integrated, adaptive assessment approach: Integrate Water Resource Management and Source-to-Sea, strategic adaptative management, best practice as a minimum for management, consistent performance for same water quality goals and risk level, flexibility in approach, continuous improvement • Principle 4: Polluter pays principle • Principle 5: Participatory approach: from early decision-making processes through monitoring and continuous assessments; participation of women in negotiation and decision-making
Regional Support and Coordination	• Regional standards, guidelines and best practice guides: coastal and marine water quality, effluent discharges, municipal wastewater management, cleaner production technologies in industries, oil spill contingency planning and disaster management • Regional reporting processes

Institutional Arrangements	• Three levels for Coastal and Marine Water Quality Management:
	  • Regional Task Force
	  • National Task Force: environmental authorities and activities potentially impacting environment (urban development and tourism, agriculture, aquaculture and forestry, industry and mining, marine transportation and energy production)
	  • Hotspot Committees: local/municipal environmental management structure and sectors; local stakeholder forums (including local industries, scientific communities, tourism organisations, recreation clubs, leaders and representative from local communities, non-government organisations)

Element	Description
Implementation (Figure 47)	• National-level coastal and marine water quality management programmes • Ecosystem-based phase approach framework • Prioritisation per hotspots: areas where coastal and marine environmental quality is most at risk or impacted by human activities • Identification and mapping of important ecosystems and key socio-economic beneficial uses in a specific area, as well as their environmental quality objectives and associated targets • Participatory approach to negotiate environmental quality objectives with local communities, as livelihoods and local economies may be affected • Identification and setting limits to potential pollution sources • Activity-based management programmes subservient to environmental quality objectives and targets • Cost of mitigation and controlling pollution sources follows pollution pay principle • Relation with other initiatives within WIO region (marine spatial planning strategy, biodiversity/conservation/fisheries strategies, ecosystem monitoring framework) • Environmental quality monitoring and evaluation programmes, shared at regular intervals with the broader society

Source: adapted from (UNEP/Nairobi Convention Secretariat; CSIR, 2021a)



Source: (UNEP/Nairobi Convention Secretariat; CSIR, 2021a)

Figure 47 – Ecosystem-based implementation Framework for coastal and marine water quality management in the Western Indian Ocean Region

Important aspects for the Strategic Framework implementation are further detailed in Table 34.

Table 34 – Key elements of implementation of Coastal and Marine Water Quality Management Programmes

Element	Description

Identification of pollution hotspots	• Valuable in areas where human capacity and/or financial resources are a constraint, concentrating the limited resources in areas of greatest risk
	• Usually coincide with coastal urban centres and industrial nodes in coastal and marine areas
	• Detailed spatial demarcation of hotspots (e.g. using numerical models) should consider:
	  • Anticipated spatial influence of human activities and developments (both in the near and far field, including land-derived wastewater discharges)
	  • Proximity of depositional areas where pollutants can accumulate (can be at distant locations for specific sources, particularly where the source discharges into a very dynamic environment but is subsequently transported to an area of lower turbulence)
	  • Possible synergistic effects (negative impacts resulting from a particular activity could be aggravated through other activities or even through interaction with natural processes)
	• Further prioritisation with the classification of the hotspots' intensity (Figure 48)
	• Emerging hotspots define areas where there are emerging issues that pose potential risks to sensitive ecosystems or beneficial uses

Important ecosystems	• Sensitive and important aquatic ecosystems • Identification and demarcation aligned with other spatial planning initiatives (conservation planning, spatial development plans, cross-sectoral marine spatial planning) • WIO: mangrove forests, seagrass beds and coral reefs

Element	Description

Beneficial uses (Figure 49)	• Uses especially reliant on acceptable water and sediment quality, typically:
	  • Recreational use: primary and secondary contact, aesthetic use
	  • Marine aquaculture: land-based, water-based; farming and protected areas for the collection of seafood for human consumption
	  • Industrial uses (e.g. desalination and cooling water intake, ballast water intake)
	• Existing uses and any future uses planned: aligning with land-use and marine spatial planning strategies and outcomes
	• Identification and demarcation aligned with other spatial planning initiatives (conservation planning, spatial development plans, cross-sectoral marine spatial planning)

Environmental quality objectives and targets	• Objectives range from abundance and diversity of biotic components to broad objectives for specific beneficial uses (e.g. safe for swimming)
	• Measurable targets for specific chemical or microbiological constituents, to use from a water quality management perspective
	• Defined by:
	  • Resource: *Guidelines for setting water and sediment quality* (UNEP/Nairobi Convention Secretariat and CSIR, 2009)
	  • Scientific assessment studies: assess whether ecosystems can support designated beneficial uses; may include baseline field measurement programmes and numerical (predictive) modelling techniques
	  • Impacts of pollution sources on ecosystems and beneficial uses: abnormal growth stimulation (e.g. excessive nutrients), biological health (e.g. toxics affecting the reproductive rate of organisms), external behaviour responses (e.g. pollutants affecting movement and habits of organisms or entanglement), human health and safety, aesthetics and nuisance, mechanical interference

Element	Description

Mapping of pollution sources (activities; Figure 49)	• Typical sectors: urbanisation and tourism; agriculture, aquaculture and forestry; industry and mining; marine transportation; energy production
	• Consider pollution sources collectively in specific areas: ensure consideration of cumulative and/or synergistic effects
	• Characterization of pollution sources:
	  • Treatment processes
	  • Volume and flow rates of waste and waste streams
	  • Physical, chemical and microbiological composition of waste and wastewater (Figure 50)

Activity-based Management Programmes	• Activities, products and services are managed to prevent undesired change to affected environment:
	  • Control or prevent pollution
	  • Achieve environmental quality objectives and targets
	• Existing and planned activities
	• Effective management, within a broader ecosystem-based approach, depends on:
	  • Formal (activity-based) legislation: enforce compliance and should not exclude incentives for implementing pollution control measures; advantageous if environmental requirements are not only present in overarching legislation (e.g. “Environmental Protection Act”) but also are embedded in sector-specific legislation (polluters take accountability for achieving legislative requirements)
	  • Standards, Guidelines and Best Practice: assist decision-maker and managers, enforce sustainable environmental best practices (emission standards, water quality standards, best practice for municipal waste and wastewater treatment, guidance on green technologies for industries); Receiving Water Quality Objective Approach (limits for pollution sources take into account the environmental quality objectives associated with ecosystems and beneficial uses, through environmental assessments) complementing Technology-based Approach (e.g. EU approach) vs usual Uniform Effluent Standard Approach
	  • Resource Planning: ensuring sufficiently skilled and motivated personnel, equipped with appropriate material and financial resources (planning, construction, operations, and even decommissioning); polluters should be held accountable for

Element	Description
	supplying resources for implementation of pollution prevention/ control measures • Contingency Planning: mitigate and control potentially detrimental impacts during unexpected mal-functioning or accidents; including mechanisms for detection of problems (early warning signal), stipulated procedures and responsibilities (schedules), action plans (site notice boards, media releases, notification of industrial users), reporting of events (procedures and protocols)
Environmental Quality Monitoring and Evaluation	• Provide the data and information to test compliance and inform activity-based management intervention • Managers of activities could be held accountable for the execution of monitoring programmes or contribute towards them • Most prevalent monitoring programmes: • Compliance monitoring (associated with specific pollution sources, e.g. municipal / industrial wastewater): source monitoring (volume and composition), system performance monitoring (status of infrastructure and treatment processes; physical inspections), environmental monitoring (receiving environment) • Beach water quality programmes (recreational use): microbiological data • Mussel watch programmes (tracking long-term trends in pollutant loading along coastal areas): target species common in coastal regions, locations supporting stable populations of bivalves, array of chemicals (metals, petrochemical, persistent organic pollutants); *NOAA mussel watch monitoring programs* • Marine litter monitoring: litter baseline; different sampling methods in different habitat types (shorelines, mangroves, water column/surface of river/estuaries, street and parks); size classes of litter*; African Marine Litter Monitoring Manual*, *GESAMP's Guidelines on the monitoring and assessment of plastic litter and microplastics in the ocean* • Dredge monitoring (disposal of material dredged from ports and harbours): national Action List (upper level and levels for constituent concentrations with acute and chronic effects on human health, ecosystems – Action Levels) as decision criteria for disposal of dredged material; *IMO Dredge material assessment framework*

Element	Description

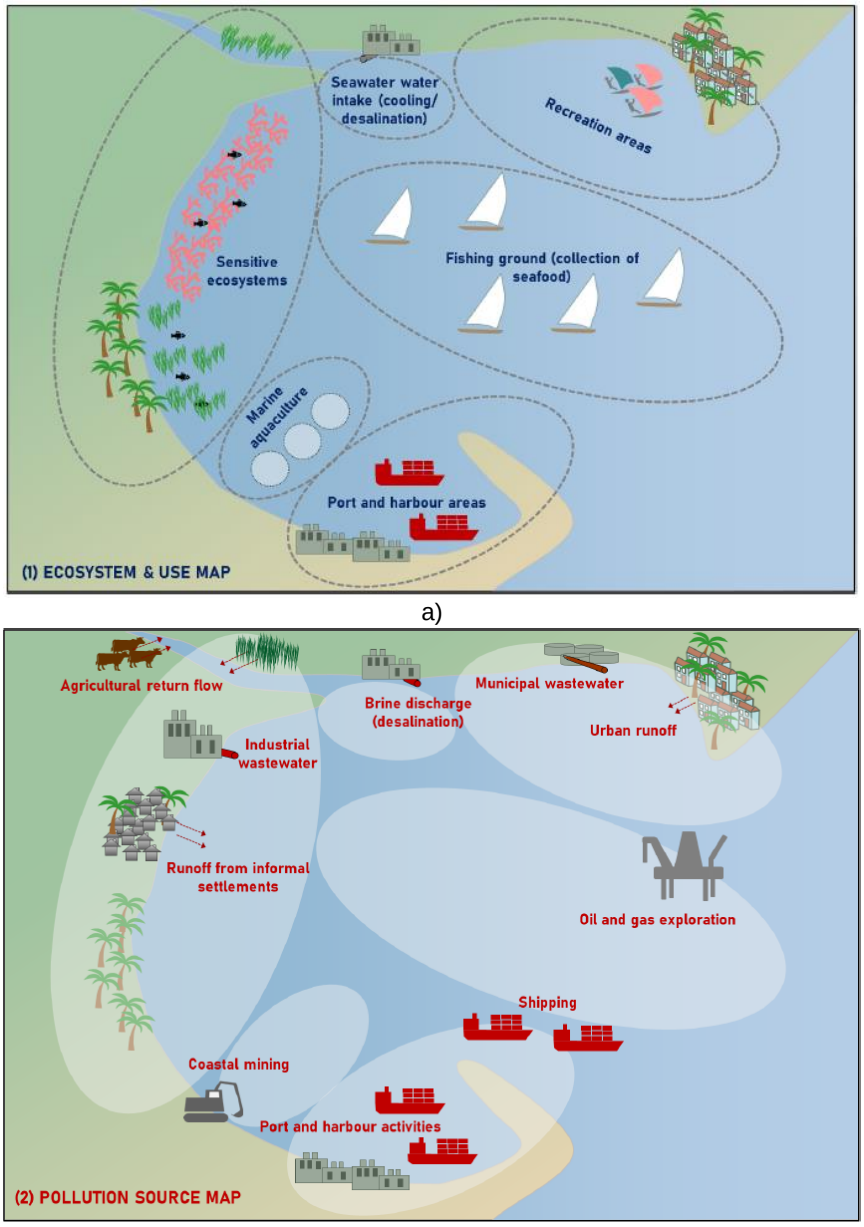
Environmental Quality Status Reporting	• Driver-pressure-state-impact-response (DPSIR) model
	• Data should flow from monitoring programs
	• Avenue to mainstream the importance and status of coastal and marine water quality within a region, country or local area, tailoring for:
	  • Regional, national and local environment planning (identification of gaps and priorities)
	  • Project identification (identification of gaps in datasets, monitoring and implementation)
	  • Cross-sector collaboration (identification for interagency collaboration required)
	  • Sustainable Development Goals (SDG) reporting (meet SDG reporting requirements)

Source: adapted from (UNEP/Nairobi Convention Secretariat; CSIR, 2021a)

		SEVERITY OF POLLUTION		
		1: Frequent non-compliance with EQTs	2: Seasonal non-compliance with EQT	3: Occasional non-compliance with EQTs
SIGNIFICANCE OF IMPACT	1 High	Category 1	Category 1	Category 2
	2 Medium	Category 1	Category 2	Category 3
	3 Low	Category 2	Category 3	Category 3
	Category 4: Emerging hotspot			

Legend: EQT – environmental quality targets
Source: (UNEP/Nairobi Convention Secretariat; CSIR, 2021a)

Figure 48 – Evaluation criteria for rating of pollution hotspots in the Western Indian Ocean Region



Source: (UNEP/Nairobi Convention Secretariat; CSIR, 2021a)

Figure 49 – Illustration of a pollution hotspot: a) important ecosystems and beneficial uses; b) pollution sources

MAJOR SECTOR & KEY ACTIVITIES SOURCE	TYPICAL POLLUTANTS																
	Thermal pollution	Brine (high salinity)	Discolouration	Solid waste (e.g. litter)	pH	Biodegradable organic matter (affecting O^2)	Suspended/settable solids	Inorganic nutrients	Microbiological contaminants	Toxic inorganics (e.g. S, Cl, CN-, NH^3)	Metals	Petrochemicals	Agrochemicals	Pharmaceuticals	Other persistent organic pollutants	Radioactive matter	Harmful organisms
URBANISATION & TOURISM																	
Municipal wastewater (incl. faecal sludge)					●	●	●	●	●	●	●			●			
Solid waste disposal				●							●			●			
Diffuse urban runoff				●	●	●	●	●	●	●	●	●	●	●			
AGRICULTURE & FORESTRY																	
Return flows							●	●	●				●				
FISHERIES AND AQUACULTURE																	
Fishing fleet waste				●													
Aquaculture farming				●		●	●	●									●
INDUSTRY & MINING																	
Desalination	●	●								●					●		
Paper & Textile	●		●	●		●	●			●							
Chemical					●	●	●			●	●				●		
Food & Beverages	●		●		●	●	●										
Coastal mining							●										
TRANSPORTATION (SHIPPING, PORTS AND HARBOURS)																	
Oils spills							●					●				●	
Ballast water discharge																	●
Harbour activities				●	●	●	●	●	●		●	●					
Dredge dumping						●	●				●	●			●		
ENERGY PRODUCTION																	
Offshore oil & gas							●			●	●	●					
Oil refineries	●				●	●						●					

Source: (UNEP/Nairobi Convention Secretariat, CSIR, 2021b)

Figure 50 – Major sectors and key activities contributing to marine pollution in the WIO region and typical associated pollutants

The Strategic Framework provides additional guidance for **the design of environmental quality monitoring programmes** in support of the marine water quality management, which comprise:

- Baseline measurement programmes: usually short-term, intensive investigations on a wide range of parameters to obtain understanding of ecosystem functioning;
- Long-term monitoring programmes: ongoing data collection programmes that are primarily targeted at continuously evaluating effectiveness of management strategies and actions designed to maintain desired environmental objectives and targets.

Key elements of each type of monitoring programmes are presented in Table 35 and Table 36.

Table 35 – Key elements of Baseline Measurement Programmes

Element	Description
Purpose	• Together with data/information on pollution sources, quantitatively assess or predict the impact of human activities and subsequently decide on appropriate management actions • Important in setting environmental water quality targets
Physical data	• Quantity hydrodynamic (or water circulation) processes and sediment dynamics, key determinants of the transport and fate of pollutants in the coastal and marine environment • Typical data and information: bathymetry, winds, waves, currents, tides, water column stratification, geomorphology (sediments characteristics and processes)
Biogeochemical data	• Data on the spatial and temporal variability of biogeochemical parameters in the water column and in the sediments: understanding key processes governing such variability • Calibration and validation of numerical modelling platforms (where applicable) • Provide a benchmark (baseline) for future long-term monitoring programmes, reflecting the present status of the receiving marine environment • Standard data: system variables and nutrients (e.g. temperature, salinity, pH, dissolved oxygen, turbidity, particulate organic carbon and nitrogen, dissolved nutrients) measured in the water column and/or sediments

Element	Description
	• Site-specific data (metals, other toxic contaminants): depend on pollution sources and effects on environment; need for a preliminary conceptual model • Initial sampling should cover near and far-field scales • Temporal scale should at least resolve natural variability

Biological data	• Geo-referenced map showing the distribution of the various ecosystem or habitat types (e.g. reefs, kelp beds, sandy and rocky bottoms), highlighting areas with:
	  • Biological resources of conservation importance
	  • Biological resources targeted for exploitation
	  • Biological resources that have been lost or are stressed as a result of anthropogenic influence
	• For each ecosystem or habitat types, a listing of the key species and their abundance and community composition, as well as expected temporal and spatial variability; alternatively focus on selected indicator species and community structure
	• Data on biological resources that are potentially sensitive to anthropogenic influences (existing or proposed) and information on cause-and-effect relationships

Source: adapted from (UNEP/Nairobi Convention Secretariat; CSIR, 2021a)

Table 36 – Key elements of Long-term Monitoring Programmes (Figure 51)

Element	Description
Purpose	• Evaluate effectiveness of management actions in achieving compliance with Environmental Quality Objectives, critical limits (e.g. wastewater emission targets) and the implementation of mitigating actions • Evaluate status and trends in the environment in terms of the health of important ecosystem components and designated beneficial uses in order to respond, where appropriate, in good time, to potentially negative impacts • Evaluate whether the predicted environmental responses, identified during the scientific assessment process, match the actual responses • Evaluate whether the initial assumptions remain valid (e.g. geographical boundary conditions)

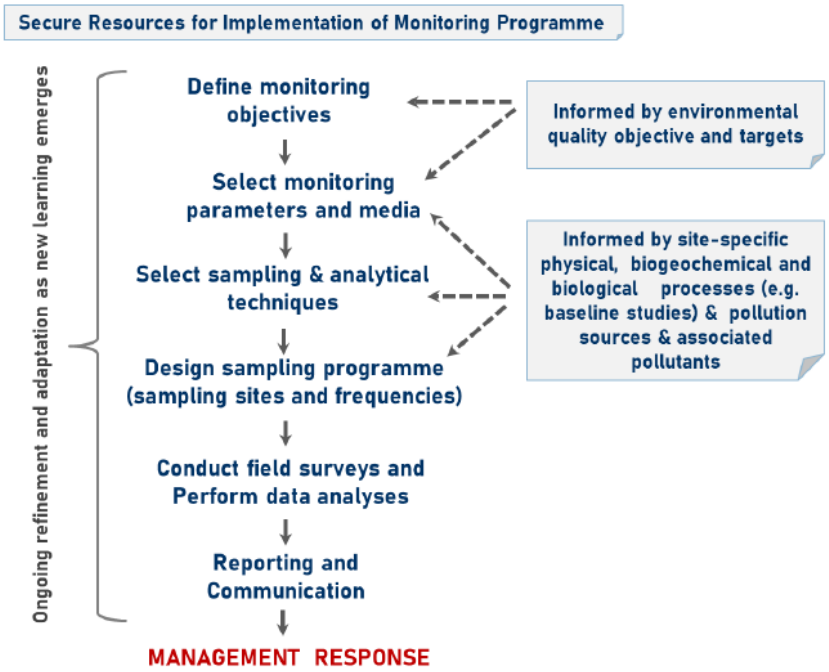
Element	Description
Sampling and analytical techniques	• Important considerations are: competent skills, budget constraints, stakeholder communication • Specify monitoring objectives • Selection of monitoring parameters (Figure 52): natural variability, pollution sources (existing, anticipated), anticipated impacts, costs and resources • Three media (water column, sediment and living organisms) based on time spans they reflect and available resources • Design of sampling: impact stations and reference/control stations; field reconnaissance for final sampling locations • Sampling strategy: probability-based (random selection) or authoritative (professional judgement) • Sampling frequency reflecting variability in contaminant loads and environmental processes, temporal sensitivity of ecosystems to pollutants

Data analyses	• Three basic approaches for data assessment:
	  • Determining trends and changes over time (e.g. for trend monitoring)
	  • Analysing the relationships between measured values for variables in the monitoring program to determine differences and the significance of the differences (e.g. for impact monitoring)
	  • Assessment of the extent to which measured water quality meets published guidelines, criteria or objectives (e.g. for compliance monitoring)
	• Develop a data management system to store data (e.g. Geographical Information Systems): procedures for recording and systematic screening and validation, secure storage, simple retrieval, simple data analysis, flexibility for additional information

Element	Description

Reporting and communication	• Dissemination of information: preparation of technical reports, scientific journals, non-technical (summary) reports, public presentations
	• Contents of monitoring reports:
	  • List of monitoring objectives
	  • Design and implementation
	  • Evaluation of monitoring data relative to objectives
	  • Statement on whether monitoring objectives have been met
	  • Possible reasons for non-compliance
	  • Management strategies/actions to address non-compliance
	  • Recommendations on refinements to the monitoring
	  • Appendices
	• Frequency of reporting: near real-time for source monitoring, six-monthly/annually for environmental monitoring programmes

Source: adapted from (UNEP/Nairobi Convention Secretariat; CSIR, 2021a)



Source: (UNEP/Nairobi Convention Secretariat; CSIR, 2021a)

Figure 51 – Components of a monitoring and evaluation programme

Relevance	Does the measurement parameter reflect directly on the issue of concern?
Validity	Does the measurement parameter respond to changes in the environment and have some explanatory power?
Diagnostic value	The measurement parameter must be able to detect changes and trends in conditions for the specified period. Can the amount of change be assessed quantitatively or qualitatively?
Responsiveness	Does the measurement parameter detect changes early enough to permit a management response, and will it reflect changes due to the manipulation by management?
Reliability	The measurement parameter should be measurable in a reliable, reproducible and cost-effective way.
Appropriateness	Is the measurement parameter appropriate for the time and spatial scales that need to be resolved?

Source: (UNEP/Nairobi Convention Secretariat; CSIR, 2021a)

Figure 52 – Criteria for identification of indicator suitability

3.3.10. National Marine Litter Action Plan for Belize

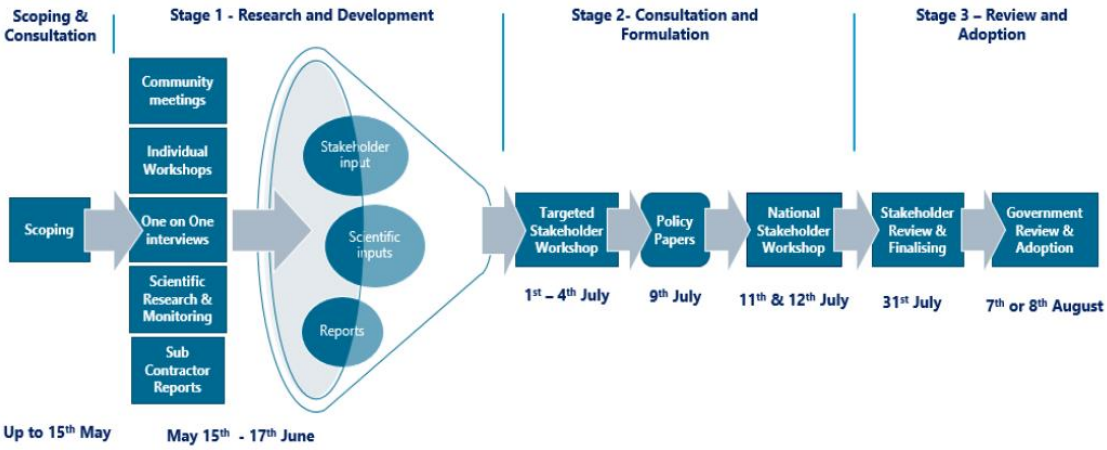
The document presents the Marine Litter Action Plan for Belize (Department of the Environment, 2019). This plan is developed under the framework of the Commonwealth Litter Programme (CLiP), delivered by the Centre of Environment, Fisheries and Aquaculture Science (Cefas), which focuses on reducing plastics and other waste entering the ocean, based on **five pillars** (land-based sources of litter; sea-based sources of litter; removal of litter from the marine environment; science; outreach and education) and contributes to delivering the objectives of Commonwealth Clean Ocean Alliance (CCOA), which calls for action to tackle single-use plastics.

Belize is a SIDS with less than 400,000 residents located both in the Caribbean and Central America, which is heavily dependent on natural resources both in land and sea. Being home to the longest continuous barrier reef of the Western Hemisphere, the marine environment is important economically through tourism and fishing sectors. Waste management is important for these sectors because waste in the marine environment cause loss of aesthetic value and of recreational opportunities (sport fishing and diving), damage to fishing vessels and fishing gear and suffer of fishing populations with reduction of fish catch.

The country, with only one sanitary landfill and 5 transfer stations, lacks necessary space and infrastructure to deal with waste generated. Together with a widespread littering habit and lack of enforcement of the population and a policy to don't allow landing of waste from international vessels in ports, due to lack of resources, this setting causes the accumulation of waste in dumpsites, mangroves and little islands and generally causes the accumulation of waste in the sea.

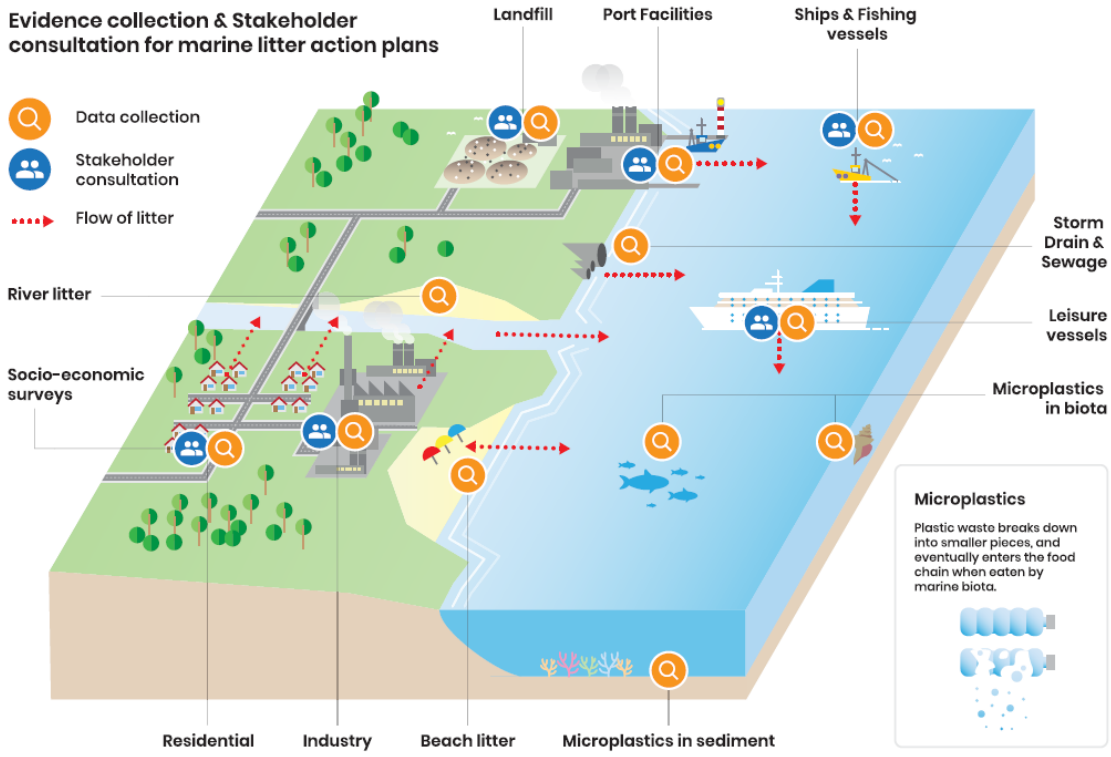
The plan was developed in a collaboration between CLiP and Ministry responsible for Environment, comprising the following **main steps**, organized in research/data collection and consultation actions (Figure 53 and Figure 54):

- Identification of institutional capacity needs to conduct monitoring;
- Stakeholder consultation: local and national government, private sector, NGOs, community groups and cooperatives;
- Capacity building for the development of a microplastic lab, monitoring for microplastic and microplastic and understanding outreach, education and waste education;
- Monitoring;
- Setup of a microplastics lab;
- Outreach/ education programme.



Source: (Department of the Environment, 2019)

Figure 53 – Stages of process of developing the Marine Litter Action Plan of Belize



Source: (Monsanto, et al., 2022)

Figure 54 – Data gathering and stakeholder consultation initiatives during the Research and Consultation phase of Marine Litter Action Plan of Belize

The work developed resulted in the identification of 25 **challenges** and corresponding **objectives**, of which some overarching challenges face across all CLiP five pillars. Stakeholder voting identify a priority level for each challenge. From these challenges are drawn strategic national policies and actions to address and reduce marine litter and strengthen waste management, centred in the following **main recommendations**:

- Develop and implement a coordinated and sustained long-term outreach campaign across multiple sectors and audiences addressing marine litter and waste management;
- Increase and strengthen data collection and enforcement for waste management to aid in evidence-based decision making and development of information for future policies and actions;
- Strengthen institutional and financial capacity to conduct scientific monitoring programme;

- Develop and implement Marine Pollution Prevention Legislation to address waste from seabased sources (maritime sector and port facilities), and marine litter in the marine environment as a measure for preventing marine litter (plastic pollution), among other marine pollution issues;
- Develop and implement a Waste Reduction Policy and Recycling Sector Policy, and legislation to formalise and standardise waste management (collection and disposal), promote the development and strengthen of a recycling sector (inclusive of source separation), and reduce marine litter generated at source;
- Work towards building capacity in Belize through the Department of Environment to focus on creating, demonstrating, and testing ideas/concepts using science to address and reduce marine litter.

The Action Plan is designed with the **main components** provided in Table 37.

Table 37 – Main strategic components of Marine Litter Action Plan for Belize

Strategic component	Description
Vision	To lead the way in tackling marine litter and its sources through a Blue, Clean, Resilient and Strong Belize.
Purpose	Provide a framework for policies and actions necessary for Belize to prevent and reduce marine litter and strengthen waste management within the marine environment: • a guide, • a management tool for resource mobilization, improved coordination among public and private sector and addressing data gaps and monitoring to improve decision making and enable evidence-based outreach and education campaign, • set recommendations for policies and actions to coordinate in the management and protection of Belize's natural resources.
Definition of Marine Litter	Any kind of material discarded or lost as a result of human activities that has made its way into the marine environment, for example material found on beaches, floating or has sunk at sea. Includes litter lost or discarded in freshwater systems on land, for example streams, rivers and lakes.

Strategic component	Description

Approach of policies / actions	• SMART (Specific, Measurable, Achievable, Realistic, Timely)
	• Circular Economy (Stahel, 2016; Geissdoerfer et al., 2017; UN Environment, 2017): turn goods that are at the end of their service life into resources for others, closing loops in industrial ecosystems and minimizing waste:
	  • Long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling to reduce emissions and leaks of material and energy as waste; presence of markets for recycled items, including end uses
	  • Address the lack of design guidelines or legal design requirements that allow the production of single use plastic items
	  • Push for a better waste management to limit the loss of material quality due to contamination and degradation when waste ends up in the environment (decrease direct and indirect costs linked with marine litter)
	• Blue Economy (United Nations Conference on Sustainable Development, 2012): ensuring environmental sustainability of the oceans and coastal areas is preserved, while balancing economic growth, social inclusion, and the preservation or improvement of livelihoods - the sustainable industrialisation of the oceans to the benefit of all:
	  • Requires collaborative management between countries and sectors
	  • Aligns with all of United Nation's Sustainable Development Goals (SDGs)

Implementation	• Led by Government of Belize, Department of the Environment
	• 5-year period
	• Actions addressing challenges with timeline, priority, objective, milestones, risks, responsibilities (lead agency, partners), relevant national and regional/international policy, funding source, cost
	• Periodic review and monitoring to determine effectiveness:
	  • Mid-reporting periods every 2 years
	  • Evaluation of overall implementation at end of year 5
	  • Actions with timelines, milestones, responsibilities

Source: adapted from (Department of the Environment, 2019)

The development and presentation of the Action Plan's actions is organised in the **5 pillars** of the CLiP. The main components of data gathering, findings and actions under each pillar are presented in the following tables and figures.

Table 38 – Components for pillars Land-based sources of marine litter and Removal of marine litter

Component	Description

Data gathering	• Solid waste generation rates and composition from households and commercial activities: collection and analysis of waste samples from several households and commercial activities; questionnaires (relate waste abundance and composition with social and economic factors):
	  • 8 areas covering urban, semi-rural and rural communities
	  • Abundance and composition: number of items, volume and weight
	  • Waste categorisation: already used CLiP list
	• Audit of waste management system in the country:
	  • Rate of satisfaction of communities
	  • Estimate of lifespan of current landfill

Findings	• Household waste contains significant portions by weight of readily recyclable and compostable materials; 10% of plastic steam is polystyrene food containers, 20% of stream is shopping plastic bags • Commercial waste is similar constituted with the exception of more recyclable paper • Sanitary Landfill's lifespan is 24; removal or recyclables and organic waste could add 10-15 years to lifespan • No or limited compaction of waste on collection and at the landfill, which could save space in landfill and waste trucks
Strategic actions	• New Waste Reduction and Recycling Policy & Legislation: towards a circular economy by developing policy and legislation that focuses on reducing packaging and ensuring that remaining packaging is easily recyclable alongside home composting; limiting the negative economic impacts and in consultation with the private sector • Formation of a Waste Producer and Recycler Association: focal point for the private sector to interact with the government; facilitate constructive collaboration and help to accelerate initiatives, acts as a conduit and facility to coordinate the private sectors efforts to build up waste management infrastructure

Component	Description
	• Support the creation and improvement of recycling and compost markets in Belize: identify markets for recyclables and compost, support the growth, development and scaling of these markets • Incentives and disincentives for the private sector: mechanisms, such as levies and extended producer responsibility, to facilitate change and attitude and approach in the private sector towards sustainable alternatives and a circular economy • Improve capacity to enforce waste management legislation: training law enforcement on how to enforce environmental laws and the consequences of non-enforcement • Looking at options for the communities to enforce littering laws in their local areas • Research and develop better packaging and products: invest in innovative and better ways of dealing with single use packaging, finding/developing alternatives and helping to develop alternative ways of thinking about waste • Provide clarity on roles and responsibilities in management of waste

Source: adapted from (Department of the Environment, 2019)

	Challenge	Objective	Risks
1	Despite a desire from the private sector to reduce waste and marine litter, commitment to implementing solutions remains patchy and uncoordinated	To coordinate and incentivise private sector engagement to reduce marine litter	Unresponsive and difficult to engage with public and private
2	A lack of effective and coordinated waste recycling and composting in country, and need for more robust infrastructure to support it	Increase resource recovery and recycling in country by supporting the growth of the recycling and composting sectors	Fluctuations in the market for resource recovery materials; increase of cost of fuel for recyclers; ,monopolization of waste collection system in Belize City; plastics classified as a hazardous material under Basel Convention and therefore more difficult to export; identification of possible use for compost by the Ministry of Agriculture; lack of national regulatory legislation or framework to manage, implement and coordinate a recycling sector
3	A poor understanding and coordination of stakeholder roles in waste management, lack of standard and unrealistic beliefs in who should pay for waste management are hampering effective waste collection	Improve coordination and understanding of the role each stakeholder plays.; clarify who pays and agree a standard approach to waste collection and management based on better understanding of roles	Low man power in the collection of waste; improper use of bins to collect household waste; lack of approved dumpsites in most municipalities, villages and communities; limited financing for improved waste collection; unwillingness to participate
4	Lack of clear, consistent and long-term communication strategy between waste management stakeholders including with the general public	Formulate an appropriately targeted communication strategy for land-based sources of marine litter and their management. This forming part of a bigger long term national waste management communication campaign on all sources and solutions to marine litter and waste management	Use of ineffective messages or media; lack of responsiveness to outreach by general public; inconsistency and correctness of the messages if not coordinated; low reach to remote communities with limited access to specific media.

Source: (Department of the Environment, 2019)

Figure 55 – Key challenges, objectives and risks of pillar Land-based sources of marine litter

Table 39 – Components for pillar Sea-based sources of marine litter

Component	Description

Data gathering	• Audits on three major ports and one marina:
	  • Volume of traffic from number of port calls of vessels at each port
	  • Estimation of amount of waste produced by different vessel categories: from IMO protocols and number of port calls
	• Some gaps / partial understanding of relative importance of different activities (shipping, tourism, fishery)

Findings	• No systematic and routine data collection on national vessels below IMO tonnages: waste stream not accounted in the design of Belizean waste management infrastructure • International shipping generates significant quantities of waste while transiting Belizean waters • No landing of waste in Belize from international shipping due to lack of port reception facilities: if ships don't offload in neighbouring states where the waste is offloaded? • No random ship inspection carried out in Belizean waters
Strategic actions	• Develop and implement a national plan to address waste from national vessels: close the data gap within existing protocols, identifying and implementing protocols where the data does not exist; aim to institutionalise MARPOL at a national level • Execute coordinated national and international audits and inspections: work with regional partners to agree and implement an approach to audit reported landing of waste; seek partnerships with other nations to share resources for random inspections of vessels at sea to check compliance • Increase awareness and compliance on proper procedures of handling waste: add marine litter awareness materials/requirements to requirements to attain new and renew existing marine licenses (e.g. tour operators, fishermen etc); combine with a nationwide awareness campaign to sensitise users to marine pollution, highlighting the damage to marine environment

Source: adapted from (Department of the Environment, 2019)

No.	Challenge	Objective	Risks
1	There is a lack of waste data on Belize's national shipping which is below IMO tonnages, therefore potentially a large unidentified and unquantified waste stream present in Belize today	Need to develop and implement a national plant to address this	Coordination of waste is spread across seven agencies (DOE, BPA, Public Health, BSWaMA, BCG and fishing and tourism sector)
2	Belize does not land international waste at its ports. However, there is no oversight of what international vessels do with the significant amounts of waste generated while navigating Belize waters. This means Belize relies on the international shipping industry to 'do the right' thing in reporting on waste management and disposal	Need to conduct a coordinated national and regional audit of waste disposal from vessels	Financing and expertise
3	Poor awareness and understanding of the causes and impacts of marine litter by small-scale commercial operators (artisanal fisherman, tour operators etc) means there is a high probability of improper waste treatment by those operators	Increase awareness and compliance with proper procedures for handling waste in the domestic shipping	Outreach—is the communication reaching the target audience

Source: (Department of the Environment, 2019)

Figure 56 – Key challenges, objectives and risks of pillar Sea-based sources of marine litter

Table 40 – Components for pillars Marine Litter Science

Component	Description

Data gathering	• Setup of specialised and fully equipped microplastics lab (direction of Department of Environment and hosted by University of Belize): funded and equipped by CLiP; training of 15 individuals across public and private sector
	• Monitoring of macroplastics (over 5 mm) and sediment grabs (microplastics <=0.5mm, using Van Veen grab) in marine (beaches immediately north and south of Belize City) and riverine sites (major river Belize River and canals of Belize City), to capture litter originated in Belize and not transboundary:
	  ◦ Schedule of monitoring and training over a 5 weeks period using OSPAR adapted to Belize conditions
	  ◦ Identification of types, quantities and accumulation rates
	• Monitoring of microplastics in subsistence biota (Queen Conch, marine, and Red Headed Cichlid, Belize River), under consultation by the Belize Fisheries Department

Component	Description
Findings	• No macroplastics were found in sediments or biota • Microplastics in all sediment samples • Low occurrence of microplastics in conch: concentration in few individuals (cellophane and polypropylene) indicate localised contamination • Microplastics in fish (cellophane and polypropylene): removal of digestive tracts before consumption indicates that no significant impact on human health is expected • Beach litter: very high level of plastic in macro litter; 20% of litter are food containers of various types • Riverbanks and drainage canals litter: food and drink litter comprise 14.4% of litter followed by paper and broken glass
Strategic actions	• Establish agreed protocols and standards for microplastics monitoring in alignment with national water monitoring protocol • Research and establish a marine litter monitoring programme: carry out a minimum 1-year monitoring programme for marine litter and use findings to establish longer-term monitoring programme • Build personnel and knowledge capacity in micro and macro plastics: CLiP has introduced leading scientific knowledge but need to train more staff across organisations and to collaborate to share resources • Train NGOs and other agencies in data collection • Underpin outreach with evidence: support the dissemination of scientific data to organisations who conduct outreach and awareness activities so that they represent issues and problems accurately

Source: adapted from (Department of the Environment, 2019)

	Challenge	Objective	Risks
1	Inclusion of standard protocols to survey marine litter and microplastics in the national water quality monitoring protocol	Adopt standardise method in the country to highlight data that must and can be collected and provide guidelines to interested stakeholders.	Unwillingness of collecting data; use of unsatisfactory data quality due to undetected low compliance with protocols.
2	Limited resilience in laboratory capacity in country to respond to personnel turnover or gear malfunction	Increase lab capacity in terms of human resources and gear in order to avoid interruptions in lab service and ensure knowledge sharing.	Loss of trained people due to loss of trained personnel before training of new operators; lack of funding to repair/replace unique pieces of equipment; lack of resources for training; concentration of capacity in only one lab.
3	Limited funding and personnel to develop and implement a comprehensive monitoring plan	Obtaining national and international funding to sustain collection of scientific data in the country.	Identification of funding agencies; deadlines of funding calls; lack of institutional capacity
4	Monitoring effort limited to few agencies with shortage of human and financial resources resulting in monitoring plans with limited geographical and temporal scope.	Increase the involvement of other partners such as NGOs and other agencies in the monitoring programmes checking for the quality of data produced.	Quality of the data; low compliance with protocols; limited resources to assist new partners in data collection.

Source: (Department of the Environment, 2019)

Figure 57 – Key challenges, objectives and risks of pillar Marine Litter Science

	Item	Mean % Composition
Belize beaches Top 10 By Number	Plastic pieces 0-2.5cm	26.0
	Plastic pieces 2.5-50cm	10.8
	Caps and lids	6.2
	Broken glass	5.0
	Polystyrene pieces 0-2.5cm	4.5
	Foam sponge (Foam cups food packs & trays) 0-2.5cm	4.5
	Crisp and sweet packets	3.4
	Drinking pouches	3.4
	Foam sponge (Foam cups food packs & trays) 2.5-50cm	3.3
	Metal bottle caps	3.1

a)

	Item	Mean % Composition
Belize River & City Top 10 By Number	Metal bottle caps	11.1
	Plastic pieces 0-2.5cm	9.3
	Crisp and sweet packets	6.7
	Plastic pieces 2.5-50cm	5.7
	Plastic bags	5.2
	Caps and lids	4.5
	Packets and bladders (aluminium foil)	4.5
	Other paper item	4.3
	Broken glass	4.3
	Foam sponge (Foam cups food packs & trays) 2.5-50cm	3.2

b)

Source: (Department of the Environment, 2019)

Figure 58 – Most frequent 10 items found in the marine litter: on beaches a), on riverbanks and city canals b)

Table 41 – Components for pillar Outreach and Education

Component	Description
Data gathering	• Educational packages incorporated into the school curriculum • Outreach activities comprising of individuals and groups from a diverse range of backgrounds, organisations and communities to provide them with science-based facts for communication about marine litter and to understand their concerns • Presentation of community packages to stakeholders
Findings	• Marine litter awareness messages are mixed, uncoordinated and in some cases provide scientifically inaccurate 'facts': reduce engagement and limit the return on investment and impact in communication for each stakeholder • Need for an overarching, long-term national marine litter communication campaign • Short duration and limited scope of previous campaigns and no metrics were gathered on the reach and impact of messages: limited identification and sharing of the best practices and communication that works • Littering laws should be shown to all that they are enforced: send a message to the public that littering is a serious problem and that it is being taken seriously • Enforcement laws need to be updated and law enforcement should receive training on how to enforce these laws and of the consequences of not enforcing

Component	Description
Strategic actions	• Updated enforcement and training for enforcers: review and update littering and enforcement laws and train enforcers on the importance of delivering them • Outreach to communities to encourage the right behaviours • Align and evidence base messages on marine litter: imperative that messages given to public are accurate with the most current information • Raise awareness of the negative impacts of littering; identify, train and support litter 'champions' to reach out to communities and share messages on the negative impacts as well as some of the solutions to marine litter • Targeting audiences and measuring message effectiveness: introduce metrics to outreach campaigns to measure effectiveness; consider using multi-media channels to reach audiences • Increase private sector partnerships in awareness: engage Corporate Social Responsibility (CSR) budgets to help focus companies on raising awareness about marine litter and to implement waste and plastic reduction initiatives in their office, in addition to getting staff to participate in community beach or river clean events • Map marine litter education packs to the national curriculum • Communicate the role of waste management agencies to the public: clear and concise information on the roles of waste management agencies to the public, encourage the thinking that waste management is everyone's responsibility

Source: adapted from (Department of the Environment, 2019)

	Challenge	Objective	Risks
1	Insufficient coordination among all organisations involved in outreach campaigns that leads to duplication of the effort and heterogeneity in the messages	Develop better mechanisms to align efforts and initiatives and standardise the messages given to the communities to increase effectiveness of outreach and avoid potentially contrasting, confusing or incorrect information	Unresponsive and difficult to engage public and private sector; limited resources; different levels of engagement level within the coordination group.
2	Wrong example given by low enforcement which undermines the effects of outreach campaigns	Increase enforcement capacity and compliance by committing more resources e.g. financial, increasing the number of enforcement officers etc.	Political interference in enforcement; low compliance by enforcement officers; lack of resources; difficulty in changing current behaviours and habits
3	The public has insufficient awareness about the adverse effects of marine litter on the economy, public health and the environment and incorrect disposal—resulting in widespread unwanted behaviour at community and individual level	Produce effective communication materials to raise awareness about the importance of managing waste correctly, modify behaviours, and explore new paths to reach different parts of the communities	Low responsiveness to outreach campaign and resistance to change behaviours, limited resources, messages not clear or easy to understand
4	More work is needed to develop and integrate educational materials on the importance of marine litter, its sources, impacts and prevention into the school curriculum for all age groups.	Map key messages about marine litter and waste management into the school curriculum via a set of Education Packs aimed at all school ages. "	Curriculum timings for school year, busy period of education, lack of interest, not making the materials easily accessible to teachers.

Source: (Department of the Environment, 2019)

Figure 59 – Key challenges, objectives and risks of pillar Outreach and Education

Proposed actions are subject to risk assessment, with identification of risks that might inhibit or prevent actions from being implemented by stakeholders and assessment by DOE, by assessing likelihood multiplied by impact and categorising risk level as Low/Medium/High/Extreme.

Financial sources pursued for Action Plan implementation comprise existing funding streams of GOB for plastic phase-out initiative and potential (Table 42).

Table 42 – Financial Sources for Marine Litter Action Plan for Belize

Existent	Potential
• Environmental Management Fund (national) (phase out of single use plastics) • Protected Area Conservation Trust (PACT) (support for phase out of single use plastics) • IDB – Solid Waste Management Project II (development of transfers stations and cost recovery initiatives as part of demonstration projects) • IDB/Japan (source separation and rural waste management technical cooperation; pilot source separation project) • IDB (waste management optimization technical cooperation; identifies the most cost-effective operational options for moving waste to the landfill)	• Community based funding via Toledo Institute for Development and Environment (beach clean ups and plastic reusing) • SIDS-DOCK (project to pilot waste to energy to reduce the burden on the waste management sector) • Seeking assistance through the GEF 7 Star Allocation and under GEF 7 International Waters or GEF 7 Marine Litter (as part of Chemicals & Waste)

Source: adapted from (Department of the Environment, 2019)

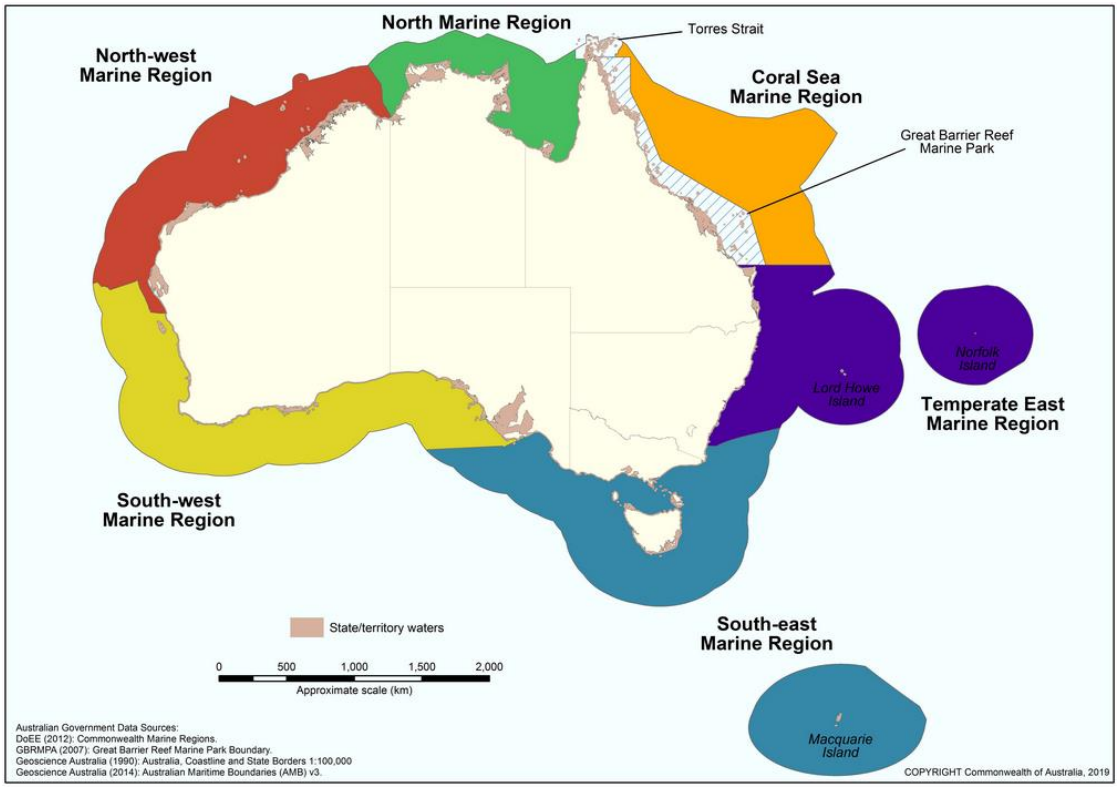
3.3.11. Australian and New Zealand Guidelines for Fresh and Marine Water Quality

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Commonwealth of Australia, 2018) is a joint initiative of the Australian and New Zealand governments and presents authoritative guidance on the management of water quality in Australia and New Zealand, including freshwater, groundwater and estuarine and marine waters:

- Focus on water quality within the context of broader ecosystem health management;
- Setting water quality and sediment quality objectives designed to sustain current, or likely future, community values for natural and semi-natural water resources, such as aquatic ecosystems, drinking water, primary industries, recreation, and cultural and spiritual values.

The Guidelines are part, together with a policy and a process (framework), of the National Water Quality Management Strategy (NWAQMS), which is a voluntary framework for water quality management for the productive and sustainable use of Australia's water resources and to protect aquatic ecosystems.

The implementation of the Guidelines occurs through Australian state and territory governments water quality planning and management policy processes of inland waters and coastal natural resources (marine planning regions in Figure 60). Complementary planning including local governments and catchment management bodies may occur at regional or catchment levels.



Source: (Commonwealth of Australia, 2018)

Figure 60 – Marine planning regions of Australia

In New Zealand, the management of freshwater quality and the coastal environment rests with the regional and local councils. The Guidelines provide guidance on physical and chemical stressors in freshwater in New Zealand together with guidance on sedimentation rate in estuaries.

The Guidelines were developed based on guiding principles presented in Table 43.

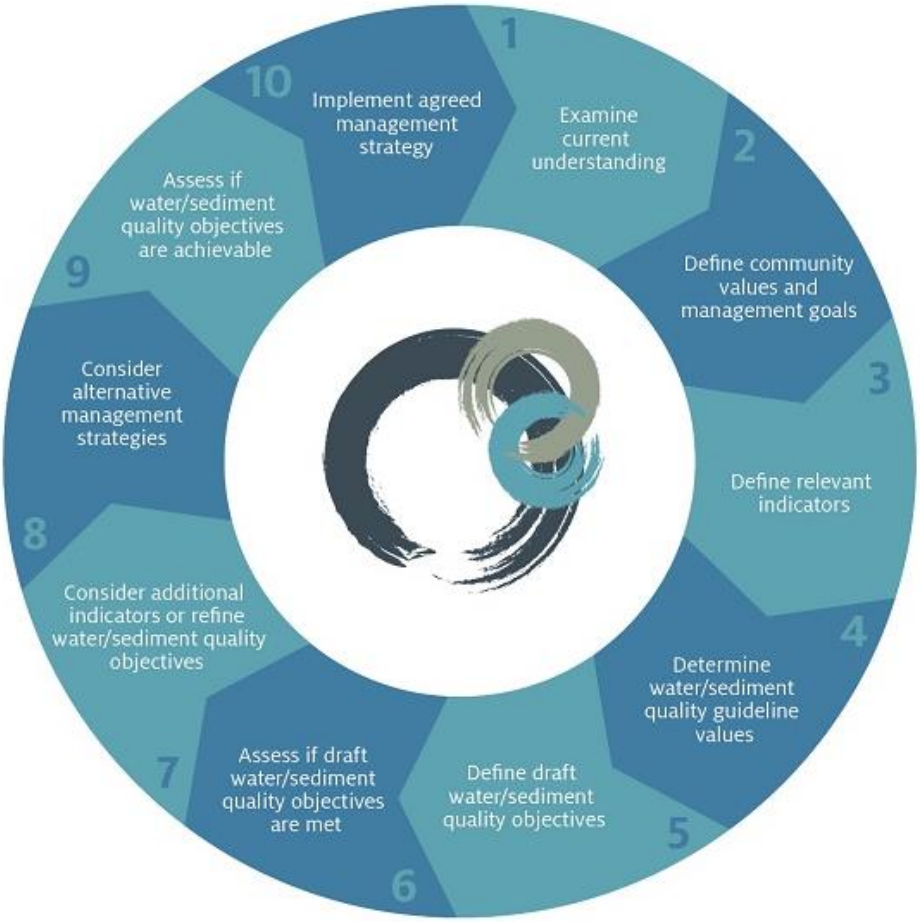
Table 43 – Guiding principles of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality

Principle	Description
Sustainable use	• Facilitate the productive and sustainable use of water resources while still maintaining the biological communities and ecological processes that the resource supports - ecologically sustainable development
Integrated planning and assessment	• Planning and management of water quality should be coordinated with management of other stressors, such as water quantity and habitat quality (for aquatic ecosystems): close alignment of water quality planning with other planning initiatives that deal with the management of water resources and ecosystem health • Management strategies should account for possible future risks, including climate change • Management and monitoring programs should consider water, sediment and biological indicators in an integrated weight-of-evidence process: a broader and more accurate assessment of ecosystem health
Tailoring for local conditions	• Stakeholder involvement to establish community values/uses and management goals for water resources • For some community values (ex. protection of aquatic ecosystems and irrigation) guideline values should also tailored to reflect local conditions
Cooperative best management	• Implementation often relies on the cooperation of all key stakeholders working together to manage the resource • High complexity inherent in water resources needs to be recognised and taken into account when determining management strategies • Development of the most effective and efficient management strategies should consider the full range of options, including promotion of best management practices and economic tools (trading schemes, incentives, etc.): preference should be given to source management rather than end-of-pipe solutions
Continual improvement	• Objectives and strategies evolve as knowledge matures: continual improvement of water resources • Because degraded systems may take time and resources to return to a satisfactory state, improvement of water quality may need to be achieved in well-defined stages, until the required water quality objective is finally met • For systems in good condition, it should be aimed to improve the water quality rather than allowing it to degrade

Source: adapted from (Commonwealth of Australia, 2018)

A Water Quality Management Framework is accomplished in the steps presented in the following figure, providing the **key requirements for long-term management strategies**:

- Good understanding of links between human activity and water/sediment quality;
- Clearly defined community values or uses, including the setting of unambiguous management goals;
- Clearly identified and appropriate water/sediment quality objectives;
- Adoption of cost-effective strategies to achieve water/sediment quality objectives.



Source: (Commonwealth of Australia, 2018)

Figure 61 – 10 steps to implement Water Quality Management Framework

The main achievements comprised in each step are presented in the following tables and figures.

Table 44 – Description of steps for Water Quality Management Framework implementation

Step	Description

1 - Examine current understanding	• Use current understanding to develop a **conceptual model** (Table 45) showing:
	  • Key waterway processes
	  • Pressures being managed and their associated stressors
	  • Key ecosystem receptors that are important to the community values
	• Types of conceptual models:
	  • Description text: easy to understand
	  • Tables
	  • Box-and-arrow diagrams: necessary to clearly communicate linkages, key components and processes
	  • Pictorial (Figure 62): boxes are replaced by representation of components, more useful for communication purpuses
	• Development/refinement of conceptual model with:
	  • Technical and stakeholder involvement workshops
	  • Existing data and scientific literature: current state and values of the waterway system, impacts and management of existing activities

2 - Define community values and management goals (Table 46)	• **Community value**: particular value or use of the environment that is important for a healthy ecosystem or for public benefit, health, safety or welfare, and requires protection from the effects of stressors (aquatic ecosystems, cultural and spiritual values, drinking water, industrial water, primary industries, recreational water and aesthetics)
	• **Management goal**: measure or statement used to assess weather community values for water quality are being attained/ maintained, should be achievable and mensurable and reflect:
	  • Reflect specific problems or threats to community values
	  • Key attributes of community values that must be protected (e.g. key processes, species of importance)
	  • Desired **level of protection** of aquatic ecosystems (degree of protection afforded to a water body based on its ecosystem

Step	Description
	condition), to maintain the existing condition/ enhance a modified ecosystem • Consistency with the aims of other related management planning processes • Typically established/refined at stakeholder involvement • Jurisdictions may already have prescribed community values (and management goals)
3 - Define relevant indicators	• Selection of indicators, using multiple lines of evidence in a weight-of-evidence process (Figure 63) for assessing and managing water/sediment quality (Figure 64; Figure 65): • Relevant **pressures**: external activities that affect water quality • Their **associated stressors** • Anticipated **ecosystem receptors** • Monitoring may be used to: • Test and validate relevant indicators • Design and develop/ refine field sampling and laboratory methodologies (e.g. associated hazard assessment for physical and chemical stressors)
4 - Determine water/sediment quality guideline values	• Guideline (threshold or condition) values for each of the relevant biological, chemical and physical indicator, that will provide the desired level of protection (if applicable) for management goals and protect the community values (Figure 66): • Use locally relevant guideline values (site-specific) • If unavailable, use default guideline values • Establish/ continue monitoring programs or laboratory / field studies to derive locally relevant guideline values
5 - Define draft water/sediment quality objectives (Figure 67)	• Ensure the protection of all identified community values and management goals (Step 2), developing objectives: • From the guideline values (Step 4) for all indicators relevant (Step 3) • From scientifically derived guideline values for quality • Choose the most stringent guideline value to ensure all community values are protected • May supplement the quality objectives with narrative statements (general description of water quality that must be attained) • Aspirational/ draft objectives that have not yet accounted for cultural, economic and social considerations

Step	Description

6 - Assess if draft water/sediment quality objectives are met	• Contrast water/sediment quality monitoring data for each relevant indicator with the water/sediment quality objectives, together with evidence from additional lines of evidence, assessing:
	  • Whether or not the objectives have been met
	  • Cause and spatial extent of any change observed
	• Objectives met if (management to focus on maintaining or improving quality):
	  • Lines of evidence considered as essential for informing acceptable water/sediment quality are met
	  • Results for other supporting lines of evidence are consistent with no compromise to current or future water/sediment quality

7 - Consider additional indicators or refine water/sediment quality objectives	• Include additional relevant lines of evidence and associated indicators if:
	  • Insufficient lines of evidence to make an evaluation of suitable quality
	  • One or more of the selected indicators proved impractical to implement, or failed to provide evidence of sufficient certainty or sensitivity.
	  • Water/sediment quality guideline values, and hence draft objectives, may need to be refined where existing guideline values are not locally relevant
	• Studies required may include:
	  • Additional monitoring
	  • Continuation or refinement of existing monitoring
	  • Dedicated laboratory or field-effects studies

8 - Consider alternative management strategies	• If quality objectives are met, can be considered options for continual improvement of management strategies • If quality objectives are not met, evaluate the effectiveness of current management strategies to address quality issues and recommend improvements • Formulate, assess and prioritise improved or alternative management strategies based on environmental considerations as well as cultural, economic and social considerations (quadruple bottom line) • Agree on final management strategies with robust stakeholder involvement (supported by monitoring, modelling, cultural, economic and social studies and multiple objective decision support tools)
9 - Assess if water/sediment quality	• If the quality objectives have not been met or are not expected to be met by management strategies of Step 8 (e.g. if costs and impacts with necessary improvements are not acceptable):

Step	Description
objectives are achievable	• Iterate through previous steps to refine components of each relevant step (e.g. improve understanding in Step 1 from monitoring and assessments in Steps 7 and 8; request stakeholder involvement in Step 2 for incremental management goals) • In extreme cases pressure may be assessed as having unacceptable quality consequences, management strategies may include rejection of development application, or closure and/or remediation strategies for existing development
10 - Implement agreed management strategy	• Suitable and agreed adaptative management process, including: • Action plans to implement management strategies • Monitoring programs to establish baselines and track improvements in management practices • Monitoring programs to establish baselines and track improvements towards water quality objectives (all indicators or lines of evidence; Figure 68) • Institutional review timeframe (assessment and review of management plans – review all steps in framework): 5 to 10 years • Implementation cycle timeframe (assessment of monitoring program and progress towards meeting quality objectives): 1 to 2 years • Continual improvement of management and monitoring • Appropriate arrangements for involving and report to stakeholders

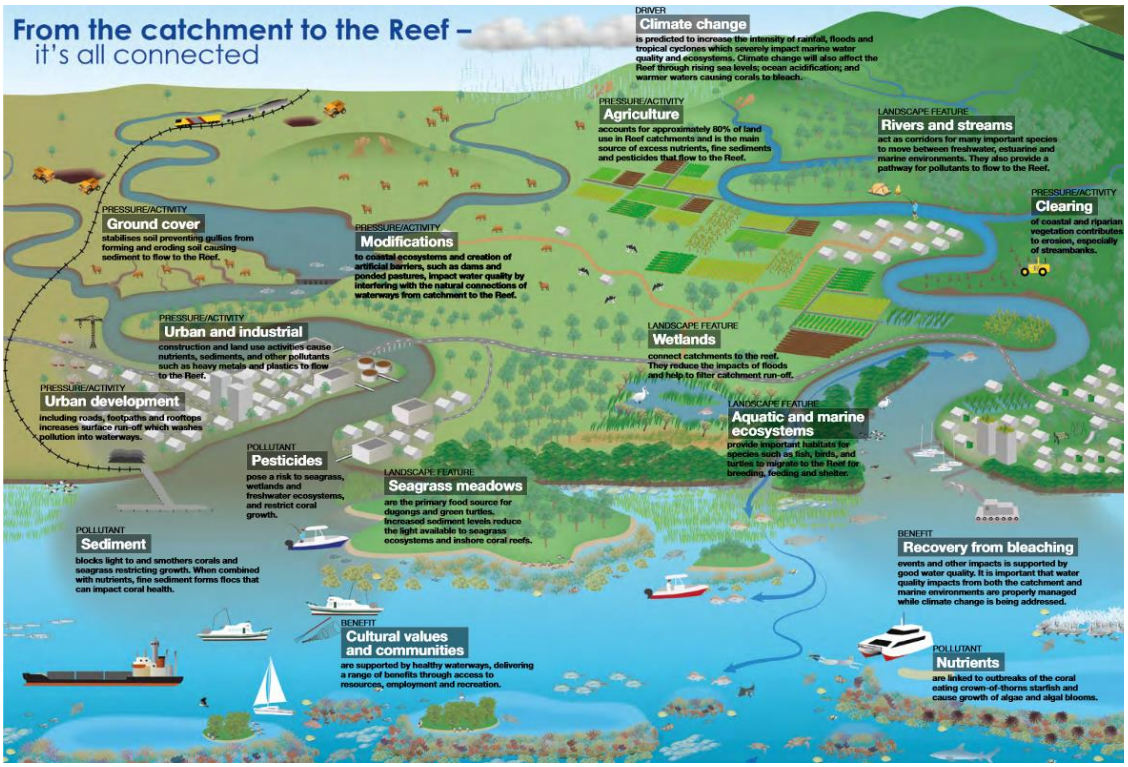
Source: adapted from (Commonwealth of Australia, 2018)

Table 45 – Description of steps for conceptual model for water quality development (Step 1)

Step	Description
1 – Identify the goals	• Goals strongly driven by the objective of the water quality management issue under consideration and influence the type of conceptual model adopted
2 – Identify bounds of the system and important subsystems	• Constraints and scope of the conceptual model
3 – Define information requirements	• Information and sources • If start by identifying all the potential information users, then the information obtained should address all the stakeholders' needs
4 – Compile available information	• Collect and check information • Identify gaps and address them • Assess limitations and restrictions due to lack of information • Information and data sources: literature review, previous monitoring and assessment, interviews, state or territory agency data compilations, other
5 – Develop conceptual process model for system/ subsystem	• Model the explicit mechanistic links between ecosystem components and processes, including controls, feedbacks and interactions • Subsystems (including ecosystem type) could include freshwater, marine waters, estuarine waters, wetland, seagrass bed, mangroves and other ecosystem types • Apart from geographical submodels, physical and chemical (and possibly trophic) submodels may be (more) relevant • Provide a narrative of what the (sub)models entail, and document supporting data and literature • Identify information gaps and further data requirements
6 – Identify natural and anthropogenic pressures and stressors	• Compile and prioritise the list of potential pressures and subsequent stressors • Pressures and stressors may act at different time and spatial scales and some are specific to particular ecosystem receptors • Identify all non-water quality related stressors that may confound interpretation of collected data, then design the study to take account of these additional stressors and ensure that weight-of-evidence results may be correctly interpreted • Identify which stressors are driving the key processes

Step	Description
7 – Develop stressor model for system/ subsystem	• If required, develop models that communicate linkages between the key causal pathway elements (pressures, stressors, and ecosystem receptors) • Models can demonstrate linkages directly relevant to the monitoring or assessment program by linking a potential indicator to relevant processes • Distil relevant information that illustrates sources of stress and the responses of the ecosystem receptors • Models need to specifically address an area or attribute that may be measured; it may be necessary to develop models at different scales and with different levels of resolution • Models need to be easy to understand and explain and have sufficient detail to clearly link a potential indicator to relevant processes.
8 – Articulate key questions/ alternative approaches and review assumptions	• Document questions/alternative hypotheses on system function that arise during construction of control and stressor models • Alternative hypotheses and models are the basis for effective adaptative management program, promote discussion on alternative management options and provide justification for future research • Document sources of evidence that have been use to formulate the model as key questions, assumptions or limitations
9 – Take model outputs to water quality management framework	• Determine management goals (Step 2) • Help set monitoring or assessment objectives (Step 2) • Determine relevant water/Sediment quality indicators (Step 3)
10 – Review, revise and refine models	• Revise periodically to accommodate new information, reflect current knowledge or meet changing needs

Source: adapted from (Commonwealth of Australia, 2018)



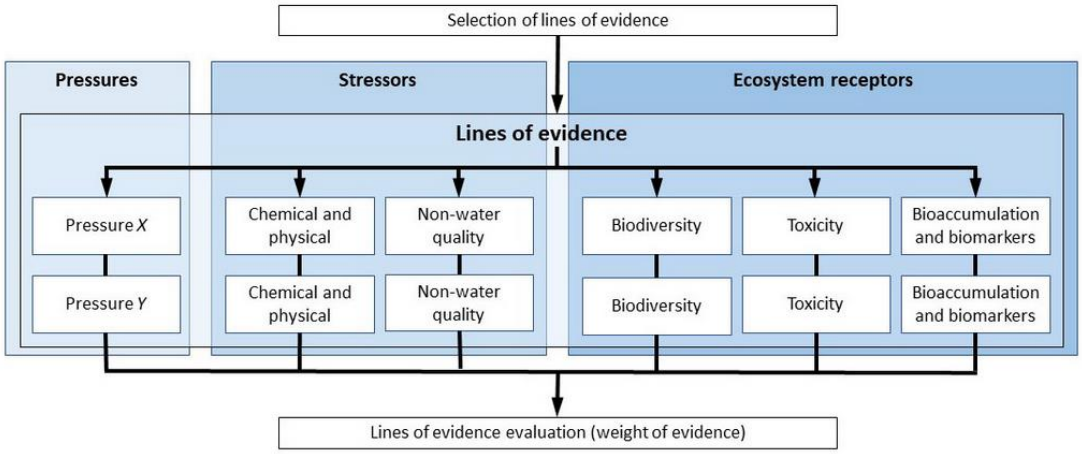
Source: (State of Queensland, 2018)

Figure 62 – Conceptual model with linkages between activities in the catchment and impacts in coastal and marine ecosystems of the Great Coral Reef (Reef 2050 Water Quality Improvement Plan, Australia; Step 1)

Table 46 – Community values and management goals defined in Reef Water Quality Improvement Plan 2017-2022 (Australia; Step 2)

Community values	• Highly valued aquatic ecosystems in the coral reefs and the lagoon and sea-floor environments
Management goal	• Protect and improve the ecosystems of the Great Barrier Reef waters, and specific goals to protect and improve the identified areas of coral reefs and seagrasses

Source: adapted from (Commonwealth of Australia, 2018)



Source: (Commonwealth of Australia, 2018)

Figure 63 – Weight-of-evidence process across the pressure-stressor-ecosystem receptor (PSER) causal pathway (Step 3)

Line of evidence	Indicator type	Indicator	Parameter
Pressure	Cropping	Pesticide use	Tonnes of insecticide applied per hectare per year
Stressor (chemical and physical)	Toxicants, or physical and chemical stressors (2 fixed types recognised)	Ammonia or dissolved oxygen	Total ammonia or dissolved oxygen in percent saturation
Stressor (non–water quality)	Altered flow or sedimentation	Stream discharge or sediment movement	Total stream volume per unit time, or sediment particle size
Ecosystem receptor (biodiversity)	Biotic assemblages or individual species	Benthic macroinvertebrate communities or species population size	Macroinvertebrate community structure or total species abundance
Ecosystem receptor (toxicity)	In situ or laboratory toxicity	Chronic toxicity to fish	14-day fish growth measurement
Ecosystem receptor (bioaccumulation & biomarkers)	Bioaccumulation, biomarkers of exposure or biomarkers of effect	Metal body burden, genetic biomarker or histopathology	Copper tissue concentration in mg/kg, DNA strand breaks or histological alterations

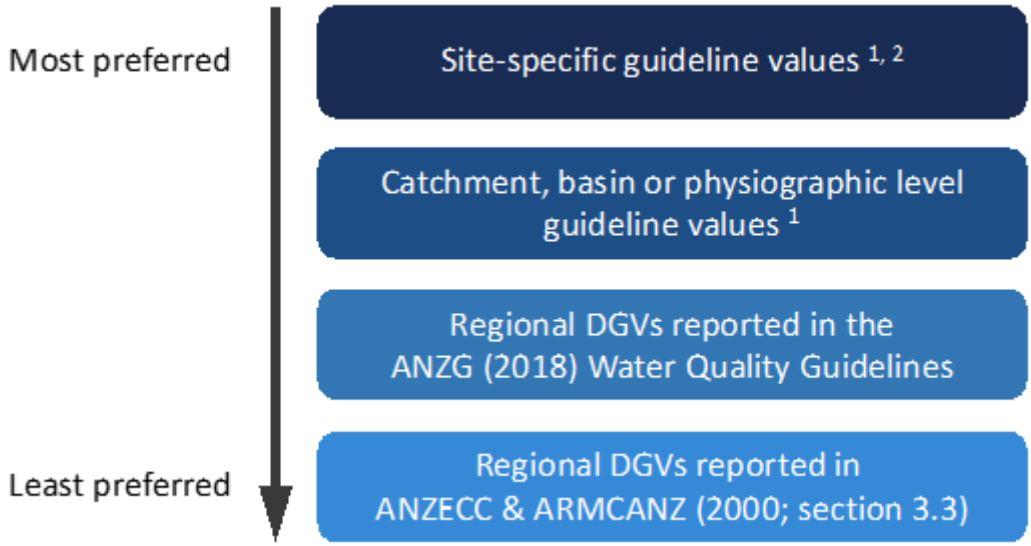
Source: (Commonwealth of Australia, 2018)

Figure 64 – Examples of indicator types, indicators and parameters relevant to each line of evidence (Step 3)

Lines of evidence	Indicators
Pressure (land use management practices)	**Adoption of better land use and management practices** • Grains management practice score • Grazing management practice score • Horticulture management practice score • Sugarcane management practice score • Bare Ground Index
Stressors (loads of nutrients, pesticides and sediments from catchment runoff)	**Nutrients** • Total nitrogen load at end-of-catchment and end-of-subcatchment areas
	Pesticides • Pesticide load at end-of-catchment and end-of-subcatchment areas
	Sediments • Sediment load at end-of-catchment and end-of-subcatchment areas
Ecosystem receptors (health of coral reefs and seagrass areas, reef lagoon water quality)	**Coral reef health** • Coral cover • Macroalgae cover • Coral juveniles • Coral cover change
	Seagrass health • Seagrass abundance • Reproduction effort • Nutrient status
	Water quality • Chlorophyll *a* • Total suspended solids

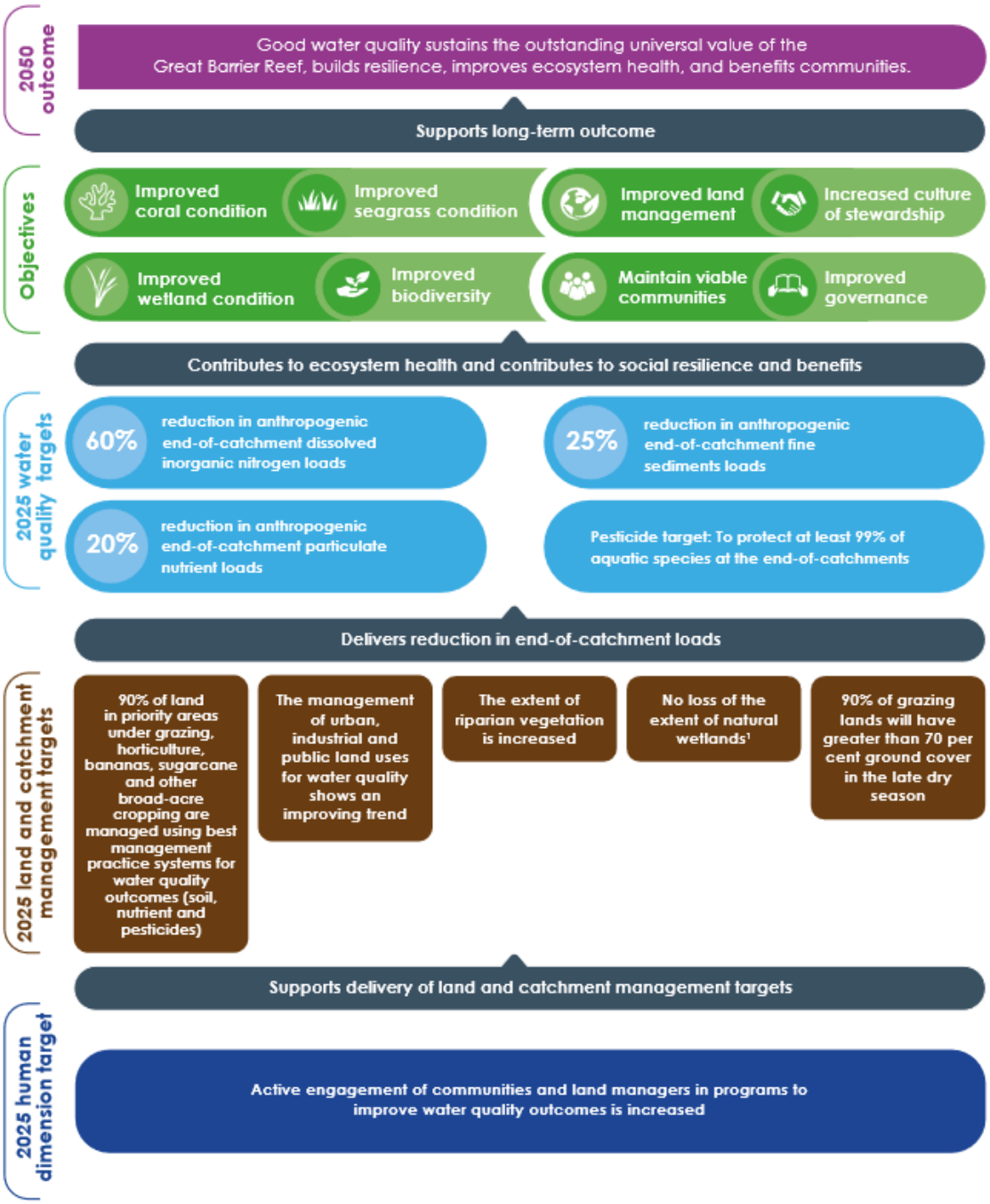
Source: (Commonwealth of Australia, 2018)

Figure 65 – Indicators to assess and monitor inshore marine condition for Great Barrier Reef (Reef Water Quality Protection Plan, Australia; Step 3)



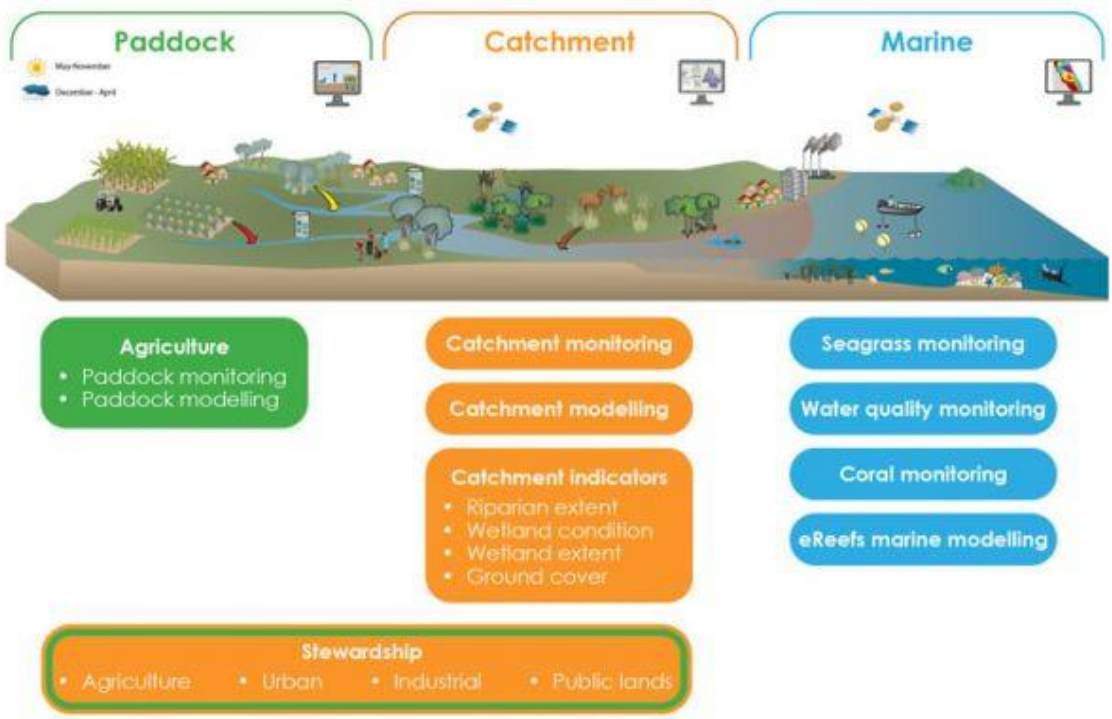
Source: (Commonwealth of Australia, 2018)

Figure 66 – Preferred hierarchy of guideline values for physical and chemical stressors (Step 4)



Source: (State of Queensland, 2018)

Figure 67 – Summary of outcome and objectives (management goals) and quality objectives (targets) for Great Barrier Reef (Reef 2050 Water Quality Improvement Plan, Australia; Step 5)



Source: (Commonwealth of Australia, 2018)

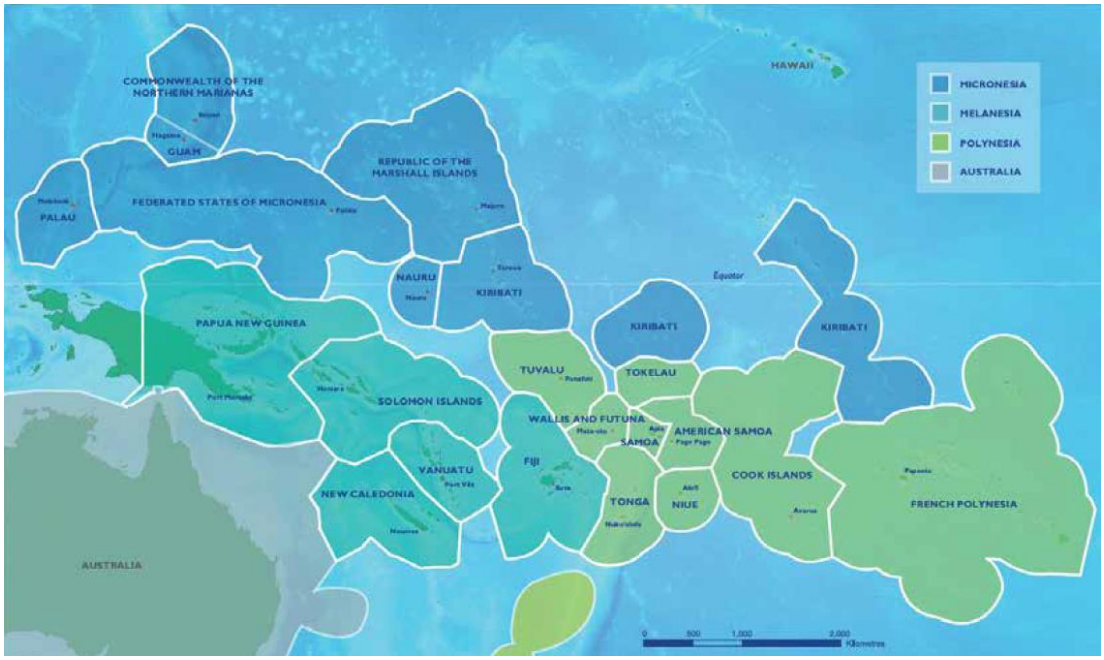
Figure 68 – Main themes of the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Reef Water Quality Protection Plan, Australia; Step 10)

3.3.12. Cleaner Pacific 2025 Strategy and Implementation Plan

The Cleaner Pacific 2025 – Pacific Regional Waste and Pollution Management Strategy 2016-2025 (SPREP, 2016) provides a strategic management framework, coordinated by the Secretariat of the Pacific Regional Environment Programme (SPREP) to address waste and chemicals management and control of pollution to reduce threats to sustainable development in the Pacific islands region:

- Waste management: waste from all sources, waste arising from disasters, asbestos, electrical and electronic waste (e-waste), hazardous waste from healthcare activities; used lead acid batteries, used oil, and liquid wastes (sewage, trade wastes and animal wastes);
- Chemicals management: including persistent organic pollutants, mercury and ozone depleting substances;
- Pollution control: from terrestrial and marine environments from poor waste management, shipping-related and marine litter.

The Pacific islands region locates in the western, northern and central Pacific Ocean and comprises 14 independent countries and eight territories that are members of the SPREP, in the three major ethnic regions of Melanesia, Micronesia and Polynesia (Figure 69, Figure 70).



Source: (SPREP, 2016)

Figure 69 – Geographical scope of SPREP Region (coastlines and marine waters within the Exclusive Economic Zone)

	Country/Territory	Land area (km²)	Mid-2013 population	Density (persons/ km²)	2013–2020 Growth rate (%)	Gross Domestic Product (in current prices)		Primary island type(s)
						Per capita (USD)	Year	
MELANESIA	Fiji	18,333	859,200	47	0.5	3,639	2011 [p]	High islands
	New Caledonia[T]	18,576	259,000	14	1.2	36,405	2010	High islands
	Papua New Guinea	462,840	7,398,500	16	2.3	18,437	2011 [p]	High islands
	Solomon Islands	28,000	610,800	22	2.4	1,676	2012	High islands
	Vanuatu	12,281	264,700	22	2.2	3,099	2011	High islands
MICRONESIA	Federated States of Micronesia	701	103,000	147	-0.2	3,031	2011 [p]	High islands
	Guam[T]	541	174,900	323	1.7	25,420	2010	Raised limestone with volcanic formations
	Kiribati	811	108,800	134	2.0	1,651	2011	Atolls
	Republic of the Marshall Islands	181	54,200	299	0.4	3,158	2011	Atolls
	Nauru	21	10,500	499	1.6	8,379	2010–11	Raised coral island
	Commonwealth of the Northern Mariana Islands[T]	457	55,600	122	1.1	11,622	2010	High islands
	Palau	444	17,800	40	0.4	10,314	2011	High islands and coral islands
POLYNESIA	American Samoa[T]	199	56,500	284	0.5	9,333	2010	High islands
	Cook Islands	237	15,200	64	0.3	17,565	2011 [p]	High islands and atolls
	French Polynesia[T]	3,521	261,400	74	0.5	26,667	2011	High islands
	Niue	259	1,500	6	-1.9	15,807	2011	Uplifted coral island
	Samoa	2,934	187,400	64	-0.1	3,680	2012	High islands
	Tokelau[T]	12	1,200	98	-0.8	NA	NA	Atolls
	Tonga	749	103,300	138	-0.1	4,557	2011–12 [p]	High islands, coral islands
	Tuvalu	26	10,900	420	1.7	3,407	2011	Atolls
	Wallis and Futuna[T]	142	12,100	85	-0.2	12,324	2005	High islands
	TOTALS	551,312	10,566,557					

Sources: SPC. 2015b. 2013 Pacific islands population poster; SPC. 2015c. 2013 Pocket statistical summary. http://www.spc.int/prism/.
Legend: A = not a member of SPREP; T = territory; NA = not available; p = provisional figure

Source: (SPREP, 2016)

Figure 70 – General characteristics of the Pacific Islands countries and territories

The region is the setting of some of the most extensive and diverse coral reefs in the world, the largest tuna fishery and healthiest remaining populations of many rare and threatened species such as whales, sea turtles, dugongs and saltwater crocodiles.

Fishing, agriculture (mainly sugar, copra, taro, bananas and beef cattle production) and tourism are the main economic activities of the Pacific islands countries and territories, while some have also significant mineral resources and forestry assets. 35% of the people live and work in towns and 12 of the 21 countries and territories are predominantly urban.

The region is vulnerable to climate change, namely coastal inundation, floods and intensified tropical cyclones. There is also high exposure to seismic hazards such as earthquakes, tsunamis and volcanic activities.

Priority areas for management include:

- Municipal solid waste;
- Asbestos;
- Electrical and electronic waste (e-waste);
- Healthcare waste;
- Chemicals (such as persistent organic pollutants, ozone depleting substances and mercury);
- Used oil and lubricants;
- Marine litter;
- Ship-sourced pollution;
- Disaster waste;
- Liquid waste (such as sewage and trade waste).

These priority waste and pollution issues are addressed in strategic actions, which incorporate **findings from the implementation of regional strategies** which it replaces (Table 47) and account for the **current situation** regarding policies and legislation, technical capacity, institutional arrangements and the priority issues (waste management, asbestos, used oil, mercury, marine pollution, marine litter and liquid waste) (Table 48, Figure 71 and Figure 72).

Table 47 – Key lessons from previous Pacific waste and pollution regional strategies implementation

Pacific waste and pollution regional strategies (replaced by Cleaner Pacific 2025): *Pacific Regional Solid Waste Management Strategy 2010–2015* *An Asbestos-Free Pacific: A Regional Strategy and Action Plan 2011* *Pacific E-waste: A Regional Strategy and Action Plan 2012* *Pacific Health Care Waste: A Regional Management Strategy and Action Plan 2013–2015* *Pacific Ocean Pollution Prevention Programme (PACPOL) 2015–2020: Strategy and Work Plans*
Key lessons from implementation: • Importance of evidence-based strategic planning: requires investment in development of data at country and regional scales in order to support clear definitions of strategic long-term goals, articulation of practical strategies and actions to progress towards these goals, and establishment of clear and measurable targets to monitor progress • Importance of a robust and flexible strategy: can be adapted to emerging priorities and take advantage of new (unexpected) funding opportunities and donor interest • Challenges of Pacific island countries and territories' capacity to implement waste, chemicals and pollutants programmes: development and implementation of specific programmes of action must be accompanied by in-country human resource support to enhance implementation success • Relevance of the technical cooperation approach (learn-by-doing): develops the technical capacity of Pacific Islanders, engenders pride in accomplishments, and, if replicated sufficiently, may ultimately lead to a degree of self-sufficiency • Importance of regional coordination: to reduce duplication and wastage of resources • Effectiveness of national and sub-regional training approaches: potentially more cost-effective than regional training activities and allow for customised instruction suited to the local situation • Importance of sustainable funding and ongoing support mechanisms: integrated into waste, chemicals and pollution management programmes

Source: adapted from (SPREP, 2016)

Table 48 – Main features of Pacific islands countries and territories concerning technical capacity and institutional arrangements for waste, chemicals and pollution management

Technical capacity	Institutional arrangements
• Some initiatives for training, development and mentoring of waste management specialists • Regional database for consolidation and evaluation of data on regional training events, trainees and trainers • Challenges: high staff turnover within national agencies, brain drain, lack of institutional support to apply new skills, insufficient number of staff available to work effectively and collectively	• In some cases waste service providers are self-regulating, leading to inefficiency • In countries and territories with decentralised administrations, urban/island councils and state governments are generally responsible for waste management services, while national or federal governments retain responsibility for chemicals and hazardous waste management and occasionally rural waste services • Despite their responsibility for urban waste service councils rarely benefit from capacity development programmes

Source: adapted from (SPREP, 2016)

National policies, strategies and plans	AS	CI	CNMI	FSM	FP	FJ	GU	KI	RMI	NA	NC	NI	PA	PNG	SA	SI	TK	TO	TV	VU	WF
Waste Policy Statement		X	ND					X			X										
Solid Waste		X*	ND	X		O	X	D*	D*	D	X	D*	X*		D*	X*	X*	D*	O	X*	X
Healthcare Waste		X*	ND	X*		D		D*	D*		O	D*	X*		X	D*	X*			X*	X
Other hazardous Waste		X*	ND	X*		O		D*	D*		X	D*	X*		D*		X*	D*			X
Liquid Waste		D*	ND	X1		O		X*	X*	D*			X*	X*	X	X1	X*	D*	X*	X*	
Chemicals		C2	ND	X		C2		C2	C2	C2				C2	D	C2		C2	C2		
Oil Spill Contingency	X	X	ND	D	X	D	X	D	D	D	X	D	D	D	D	D	D	X	D	D	X
Air Pollution			ND	X		O															

Legend: C = preparation has commenced; D = document has been prepared but not yet endorsed; O = endorsed document is no longer current; X = document has been endorsed and is current; ND = no data; * = part of an integrated policy, strategy or plan; 1 = for sanitation only; 2 = for POPs only

(AS-American Samoa, CI-Cook Islands, CNMI-Commonwealth of the Northern Mariana Islands, FSM-Federated States of Micronesia, FP-French Polynesia, FJ-Republic of Fiji, GU-Guam, KI-Republic of Kiribati, RMI-Republic of the Marshall Islands, NA-Republic of Nauru, NC-New Caledonia, NI-Niue, PA-Republic of Palau, PNG-Papua New Guinea, SA-Samoa, SI-Solomon Islands, TK-Tokelau, TO-Tonga, TV-Tuvalu, VU-Vanuatu, WF-Wallis and Futuna)
Source: (SPREP, 2016)

Figure 71 – Status of waste, chemicals and pollution policies in Pacific islands countries and territories

Country / Territory	National improved sanitation		Sewer connections			Volume of sewage collected (Megalitres/year)
	% population	Year	Number of connections	Population served	% population served	
American Samoa	83.6	2010	5,000	23,000	41	2,304
CNMI	ND	-	ND	ND	ND	ND
Cook Islands	100	2010	250	1,000	7	37
Federated States of Micronesia	56.5	2010	2,376	12,405	12	1,367
Fiji	83	2010	28,204	132,559	15	18,401
French Polynesia	96.3	2012	ND	52,280	20	ND
Guam	ND	-	ND	ND	ND	ND
Kiribati	31.2	2009	2,282	15,974	15	383
Marshall Islands	75	2010	2,620	22,608	40	194
Nauru	65	2010	0	0	0	N/A
New Caledonia	ND	-	ND	ND	ND	ND
Niue	100	2010	0	0	0	N/A
Palau	100	2010	2,240	11,200	54	4,150
PNG	83.5	2010	17,618	154,177	2	28,724
Samoa	98	2010	75	120	0	8
Solomon Islands	17.6	2007	916	6,412	1	574
Tokelau	93	2010	0	0	0	N/A
Tonga	99	2010	0	0	0	N/A
Tuvalu	85	2010	0	0	0	N/A
Vanuatu	57	2010	0	0	0	N/A
Wallis and Futuna	97.8	2013	ND	ND	ND	N/A
Regional	-	-	61,581	431,735	4%	56,142

Sources:
SPC. n.d. Pacific National Minimum Development Indicators. http://www.spc.int/nmdi/environmental_health.
Pacific Water and Wastes Association. 2013. Pacific water and wastewater utilities benchmarking report. Apia: Pacific Water and Wastes Association.
National Institute of Statistics and Economic Studies. n.d. Légère croissance de la population en Polynésie française malgré un déficit migratoire sans précédent [Slight growth of the population in French Polynesia despite an unprecedented migration deficit]. http://www.insee.fr/fr/themes/document.asp?reg_id=0&ref_id=ip1474.

Legend: N/A = not applicable (no sewerage system in place); ND = no data

Source: (SPREP, 2016)

Figure 72 – Status of sanitation and sewerage in Pacific islands countries and territories

The Strategy is articulated in **Vision, Mission, guiding principles, strategic goals, performance indicators, targets and 15 Strategic Actions** as summarized in Figure 73.

Vision	A cleaner Pacific environment					
Mission	To implement practical and sustainable solutions for the prevention and management of waste and pollution in the Pacific					
Guiding Principles	Strategic Goals	Performance Indicators	2014 Baseline	Targets		Strategic Actions
				By 2020	By 2025	
1. Reduce, Reuse, Recycle, Return (3Rs +Return) 2. Product stewardship 3. Polluter pays principle 4. Proximity principle 5. Transparency 6. Public consultation and participation 7. Multisectoral approach 8. Regionalism 9. Sound decision-making 10. Precautionary approach 11. Proactive approach 12. Adherence to regional and international conventions 13. Public-private partnership 14. Selection of appropriate and affordable technology	Prevent and minimise generation of wastes and pollution and their associated impacts	Per capita generation of municipal solid waste (kg/person/day)	1.3	1.3	1.3	**Strengthen institutional capacity** 1. Undertake regular WCP data collection and management (including storage, interpretation, dissemination and sharing) 2. Develop and enforce national policies, strategies, plans and legislation, and strengthen institutional arrangements **Promote public-private partnerships** 3. Develop new public private partnerships including through strengthened public-private partnership frameworks **Implement sustainable best practices in WCP management** 4. Implement best practice occupational health and safety measures 5. Implement WCP prevention and reduction programmes 6. Implement resource recovery programmes 7. Remediate contaminated sites and WCP stockpiles 8. Expand user-pays WCP collection services 9. Improve WCP management infrastructure and support sustainable operation and maintenance 10. Implement best practice environmental monitoring and reporting **Develop human capacity** 11. Implement sustainable human capacity development programmes **Improve dissemination of outcomes and experiences in WCP management** 12. Utilise project outcomes to implement regional and national WCP education and behavioural change campaigns **Promote regional and national cooperation** 13. Establish a regional Clean Pacific Roundtable 14. Strengthen national and regional cooperation and coordination 15. Cooperate to ensure timely monitoring of Cleaner Pacific 2025
		No. of marine pollution incidents	6 (2 PICTs)	0	0	
		No. of port waste reception facilities	5	10	20	
	Recover resources from wastes and pollution	Waste recycling rate (=amount recycled, reused, returned/ amount recyclable) (%)	47%	60%	75%	
		No. of national or municipal composting programmes	18	30	40	
		No. of national or state container deposit programmes	4 (KI, PA, Kosrae, Yap)	7	10	
		No. of national EPR programmes for used oil	2 (NC, FP)	3	10	
		No. of national EPR programmes for e-waste	1 (NC)	5	8	
	Improve life-cycle management of residuals	No. of national or state user-pays systems for waste collection	9	14	21	
		Waste collection coverage (% of population)	88% (urban) (= 35% nationally)	100% (urban) (= 40% nationally)	60% (nationally)	
		Waste capture rate (= amount collected/amount generated) (%)	Insufficient data	Establish baseline & targets		
		No. of temporary, unregulated and open dumps	Over 250	237	225	
		Quantity of asbestos stockpiles (m^3)	> 187,891 m^2	159,700 m^2	131,500 m^2	
		Quantity of healthcare waste stockpiles (tonnes)	> 76 tonnes	< 20 tonnes	0 tonnes	
		Quantity of e-waste stockpiles (tonnes)	Insufficient data	Establish baseline & targets		
		Quantity of used oil stockpiles (m^3)	2,960 m^3	1,480 m^3	0 m^3	
		Quantity of pharmaceutical and chemical stockpiles (tonnes)	Insufficient data	Establish baseline & targets		
		Urban sewage treated to secondary standards (%)	65%	Establish after regional assessment		
	Improve monitoring of the receiving environment	No. of water and environmental quality monitoring programmes	~ 3 (AS, CI, GU)	5	7	
		No. of national chemicals and pollution inventories	2 (SA, PA)	3	6	

(WCP-Wastes, chemicals and pollutants)
Source: (SPREP, 2016)

Figure 73 – Summary of main components of Cleaner Pacific 2025 Strategy

The **implementation, monitoring, evaluation and funding mechanisms** for the Cleaner Pacific 2025 Strategy are presented in the Table 49.

Table 49 – Implementation, monitoring, evaluation and funding mechanisms for the Cleaner Pacific 2025 Strategy

Component	Description
Implementation	• Activities to carry out proposed strategic actions are detailed in two four-yearly implementation plans • Address the Cleaner Pacific 2025 Strategy in appropriate national processes to improve the mainstreaming of activities into national and corporate work programmes and budgets, improving implementation
Monitoring	• Submission of annual reports to SPREP with national changes in performance indicators and record and report on actions implemented against the Cleaner Pacific 2025 implementation plan • SPREP to prepare a regional synthesis of national reports and coordinate face-to-face discussions • Update regional key performance indicators as necessary

Evaluation	• Participative mid-term review in 2020 coordinated by SPREP and active involvement of Pacific islands countries and territories and other stakeholders:
	  ◦ Verify and evaluate the relevance of strategic actions
	  ◦ Identify necessary corrective actions and strategic recommendations for the second half of the strategy period (2021–2025)

Component	Description
Funding	• Clean Pacific Roundtable (Strategic Action 13): • A forum that facilitates dialogue on waste and pollution management needs and priorities • Promotes networking between Pacific island countries and territories, donors, development partners, civil society, regional organisations and the private sector • Disseminates information on new and existing funding opportunities • Resource mobilisation strategies: • Mainstreaming waste and pollution management considerations into other priority development areas (climate change, biodiversity conservation, agricultural/tourism development) • Building awareness of the importance of improving waste and pollution management with politicians, decision makers and communities • Formal adoption of Cleaner Pacific 2025 at the national level and incorporation into national waste and pollution management strategies, and national and corporate work programmes and budgets • Leveraging available national funding allocations for waste and pollution management.

Source: adapted from (SPREP, 2016)

The present **Cleaner Pacific 2025 Implementation Plan** (SPREP, 2022) was developed based on:

- Mid-term review of Cleaner Pacific 2025 (Table 50);
- Feedback survey, comprising a draft Implementation Plan framework, distributed to all Pacific island countries and territories, as well as regional implementation partners;
- Three online sub-regional consultation meetings, attended by representatives from SPREP, JICA/J-PRISM II, Polynesia, Melanesia and Micronesia.

In the Implementation Plan 2021-2025 identifies specific **high-priority waste management and pollution control activities** linked to the strategic actions and performance indicators, allocating lead agencies and partners to activity delivery (Table 51).

Table 50 – Mid-term review findings for Cleaner Pacific 2025

Review issue	Description
Performance indicators exceeding targets regionally	• Per capita generation of municipal solid waste (reduced) • No. of national or state container deposit programmes (increased) • No. of national Extended Producer Responsibility programmes for used oil (increased) • Waste collection coverage (increased) • No. of PICTs with water or environmental quality monitoring and reporting programmes (increased) • No. of national chemicals and pollution inventories (increased)
Performance indicators not meeting targets regionally	• No. of marine pollution incidents; • No. of port waste reception facilities; • No. of PICTs with national, state or municipal composting programmes; • No. of national EPR programmes for e-waste; • No. of PICTs with national, state or municipal user-pays systems for waste collection; and • Quantity of used oil stockpiles.
Key recommendations for 2021-2025 Implementation Plan	• Adopt a streamlined approach using the Cleaner Pacific 2025 performance indicators as the primary means for assessing implementation progress • Revise performance indicators to support more robust monitoring and reporting, with realistic targets • Focus on a limited number of high-priority activities, addressing key implementation gaps and current priority issues: all activities must be logically linked to performance indicators and strategic goals • Review strategic goals: 1 to 3 remain valid but 4 should be revised to “improve monitoring and reporting”, to encompass monitoring and reporting for both management activities and the receiving environment

Source: adapted from (SPREP, 2022)

Table 51 – Strategic goals, performance indicators and activities of Cleaner Pacific 2025 Implementation Plan 2021-2025

Strategic goals	Performance indicators	Activities
1.Prevent and minimise generation of wastes and pollution and their associated impacts	• Per capita generation of municipal solid waste (kg/person/day)	• 1.1 Implement measures to restrict and regulate the importation, sale and use of potentially wasteful products (e.g. single-use plastics, Styrofoam, low quality goods, products close to expiry dates) • 1.2 Develop and implement waste minimisation education and behavioural-change programmes in partnership with schools, churches, community organisations and the private sector • 1.3 Implement community-based projects to raise awareness of marine litter (e.g. installation of litter booms and litter bins, organised clean-ups and assessment of collected litter, identification and use of alternatives to wasteful products)
	• No. of marine pollution incidents	• 1.4 Prepare a regional template to guide the development of national pollution prevention strategies (NATPOLs) • 1.5 Actively resource, apply, monitor and enforce the 2017–04 Conservation Management Measure on Marine Pollution
	• No. of port waste reception facilities	• 1.6 Undertake port waste reception facility gap analyses in accordance with IMO procedures • 1.7 Prepare guidance and assist PICTs with the development and maintenance of port waste reception facilities

Strategic goals	Performance indicators	Activities
2.Recover resources from wastes and pollutants	• Waste recycling rate (=amount recycled, reused, returned/amount recyclable) (%)	• 2.1 Develop a regional recycling association to facilitate networking, information sharing and capacity-building across national recycling associations • 2.2 Evaluate existing resource-recovery initiatives and make recommendations for improvements and potential replication regionally and nationally • 2.3 Establish material recovery facilities to support waste segregation and recycling
	• No. of PICTs with national, state or municipal composting programmes	• 2.4 Establish new or strengthen existing composting projects for the integrated management of organic waste streams (household organic waste, market and animal wastes)
	• No. of PICTs with Advanced Recovery Programmes (e.g. CDP, EPR, advanced recycling fee, advanced disposal fee, waste levy)	• 2.5 Support PICTs to draft, consult on and enact regulatory and policy frameworks/instruments to implement container deposit programmes • 2.6 Support PICTs to develop and implement management plans and establish formal public-private partnerships to support EPR programmes for used oil • 2.7 Support PICTs to develop formal public-private partnerships that establish EPR programmes for e-waste
3.Improve life-cycle management of residuals	• No. of PICTs with national, state or municipal user-pays systems for waste collection	• 3.1 Investigate factors for successful user-pays waste collection systems and support PICTS with the establishment of new systems that suit their national contexts
	• Waste collection coverage (% of population) • Waste capture rate (= amount collected/amount generated) (%)	• 3.2 Undertake time and motion studies to inform waste collection coverage, efficiency and safety (especially after the hiring of new contractors, procurement of new equipment, establishment of new disposal facilities or waste transfer stations, or the expansion of urban settlements)

Strategic goals	Performance indicators	Activities
	• No. of PICTs with well-managed waste disposal facilities • No. of PICTs with climate-proofed waste disposal facilities	• 3.3 Improve landfill infrastructure by upgrading and climate-proofing existing landfills; establishing new sanitary, climate-proof landfills; and closing and rehabilitating temporary, unregulated and open dumps • 3.4 Develop guidelines, operational manuals and maintenance plans for landfills and other waste disposal facilities, including siting recommendations and occupational health and safety measures • 3.5 Develop national plans for disaster waste management • 3.6 Support PICTs to improve their WCP equipment maintenance capacity
	• No. of national strategies for safe and effective asbestos management and remediation	• 3.7 Support PICTs in developing national strategies to regulate/ban the importation of asbestos, and implement safe and effective asbestos management and remediation • 3.8 Support PICTs to safely assess, collect, remove and dispose of legacy asbestos wastes
	• Quantity of healthcare waste stockpiles (tonnes)	• 3.9 Ensure appropriate management of healthcare waste, including correct operation of incinerators
	• Quantity of e-waste stockpiles (tonnes)	• 3.10 Establish baseline data on e-waste stockpiles and support PICTs in developing e-waste EPR programmes and recycling systems, including e-scrapping and dismantling
	• Quantity of used oil stockpiles (L)	• 3.11 Establish collection, treatment, recycling and disposal systems for used oil
	• No. of PICTs providing secondary or better wastewater treatment	• 3.12 Develop and construct pilot decentralised liquid waste management programmes and sludge treatment facilities

Strategic goals	Performance indicators	Activities
4.Improve monitoring and reporting	• No. of endorsed and current national strategies/policies for WCP management with monitoring and reporting frameworks	• 4.1 Support PICTs in the development and endorsement of integrated national WCP management strategies and plans • 4.2 Establish and support national WCP steering committees to strengthen the implementation of national WCP management strategies and plans, and the coordination and monitoring of WCP activities across responsible agencies
	• No. of PICTs with water or environmental quality monitoring and reporting programmes • No. of PICTs with WCP monitoring and reporting programmes	• 4.3 Develop, publish and disseminate a standardised monitoring and reporting system and database, linked to SPREP's Inform project, covering WCP management activities and the receiving environment • 4.4 Develop and implement national systems for routine monitoring and reporting for the receiving environment (water and/or environmental quality) • 4.5 Develop and implement national systems for routine monitoring and reporting for WCP management activities
	• No. of PICTs with national chemicals inventories	• 4.6 Support PICTs to prepare national chemicals inventories, and to be compliant with their obligations under chemicals-related Multilateral Environmental Agreements

Notes: PICT – Pacific island countries and territories, WCP – waste, chemicals and pollutants.
Source: adapted from (SPREP, 2022)

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4. Relevance of methods, tools and good practices

4.1. Contents and overview

This chapter aims to assess the relevance of the methods, tools and good practices reviewed in previous chapter for improving marine pollution management in Barbados (sub-task 3.2 in Work Plan for the Assignment).

Work is accomplished in the following steps:

- Development and evaluation of options for facilitating marine pollution management;
- Definition of system of indicators and metrics to inform selection of preferred options for methods, tools and good practices.

4.2. Context of Barbados

In this section the relevance of the methods, tools and practices reviewed is assessed considering the geographical, environmental and socio-economic context of Barbados, considering the following issues:

- Measurement, quantification and management of polluting economic activities, including indicators and metrics;
- Evaluation of different options for management of marine pollution, including indicators and metrics to inform the selection of a preferred option;
- Monitoring, evaluation of results of implementation of marine pollution management strategies and design of amendments and revisions of plans and policies.

In assessing the usefulness of the methods, tools and practices reviewed it is firstly considered the requirements of the two main strategic sources guiding the present assignment (cf. section 3.2):

- **Sustainable Development Goals 1, 2, 3, 6, 8, 9, 11, 12, 13, 14 and 15 and targets**: focus on ecosystems, human health and livelihoods protection and on reducing vulnerability to climate change, through international action on pollution due to waste, wastewater, hazardous chemicals, nutrients and ocean acidification, focusing of urban, agriculture and fishing, tourism sectors and adopting water and resource efficiency and integrated water resources management;
- **Regional Strategy for the Protection and Development of the Marine Environment of the Wider Caribbean Region**, namely focusing on the priority pollution issues of litter and microplastics, wastewater, nutrients and ocean acidification through an ecosystem-based and knowledge-based management approach, pollution prevention and reduction tools and circular economy (waste as resource and sustainable consumption and production) approaches, fostering the transition to sustainable ocean-based economies.

Facing these requirements the present marine pollution management framework is characterized by the following challenges (cf. D2 – Situation Analysis):

- Lack of in-force regulations (namely under the Marine Pollution Control Act) and enforcement capacity (by EPD);
- Planning and action is sectoral and corrective, not integrated and preventive;
- Limited monitoring and communication, not allowing for sound knowledge-based management;
- An unsuccessful previous attempt of an unified/integrated strategy and action towards marine pollution from land-based sources, the National Programme of Action for the Marine Environmental from Land Based Sources of Pollution (Government of Barbados, 2007), due to lack of collaboration and articulation between multiple institutions involved.

In this context, five reviewed frameworks can be firstly highlighted as relevant in guiding the **general development** of a strategy and action plan for a pro-active integrated marine pollution management:

- Marine Strategies for Portuguese Marine Waters / Madeira Islands (guideline 5), based on the Marine Strategy Framework Directive;
- Western Indian Ocean Strategic Framework for Coastal and Marine Water Quality Management (guideline 9);
- National Marine Litter Action Plan for Belize (guideline 10);
- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (guideline 11);
- Cleaner Pacific 2025 Strategy and Implementation Plan (guideline 12).

The diversity of approaches comprised in these guidelines in relation with the main strategic requirements presented before is presented in the following table.

Table 52 – Approaches followed by selected guidelines concerning the general development of strategy/action plan for marine pollution management

Guidelines:
5 - Marine Strategies for Portuguese Marine Waters / Madeira Islands; **9** - Western Indian Ocean Strategic Framework for Coastal and Marine Water Quality Management; **10** - National Marine Litter Action Plan for Belize; **11** - Australian and New Zealand Guidelines for Fresh and Marine Water Quality; **12** – Cleaner Pacific 2025 Strategy and Implementation Plan

Approach	Guidelines				
	5	**9**	**10**	**11**	**12**
Ecosystem-based	√	√		√	
Knowledge-based		√		√	
Stakeholder/Users-based		√	√	√	√
Several pollution issues	√	√		√	
Circular economy			√		√
Adaptative management	√	√		√	
SIDS relevant		√	√		√

From this analysis it can be observed that guidelines 9 and 11 provide a more complete fulfilment of the strategic requirements and in general both guidelines are very similar, prescribing 8 and 10 steps for management programmes involving the identification/definition of:

- Important ecosystems and beneficial uses / community values;
- Environmental quality objectives/management goals;
- Environmental quality targets / quality objectives;
- Activity-based management programmes / management strategies;
- Adaptative management of activity-based management programmes / adaptative management of all management frameworks.

Guideline 11 provides overall more detailed guidance.

However, guidelines 9, 10 and 12 provide **specific management solutions for SIDS** problems concerning human capacity and financial resources which can be useful for application in Barbados, including:

- Management concentrated in hotspots (guideline 9); prioritization of areas for action is also referred as orientation for the Caribbean context by guidelines 7 and 8;
- Mainstreaming marine pollution management into other priority development areas (climate change, biodiversity conservation, agriculture/tourism development) (guideline 12);
- Coordinate with regional partners the audits and inspections on ships for MARPOL compliance (guideline 10).

Finally, guidelines 10 and 12 also provide interesting solutions aligned in a **circular economy approach** which can be relevant in the context of Barbados, including measures fostering waste recycling and composting. Composting can also be beneficial in nutrient pollution management, if replacing the use of fertilizers. In general, these guidelines are a good source of management actions in SIDS context which are interesting for Barbados.

The remaining guidelines contemplate established guidance on relevant issues for marine pollution management in Barbados:

- Waste and other pollution monitoring: UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter (guideline 1), NOAA Guidelines for the Monitoring and Assessment of Plastic Litter in the Ocean (guideline 2), OSPAR Coordinated Environmental Monitoring Programme (guideline 6);
- Management of health hazards in recreational use of coastal waters: WHO Guidelines for safe recreational water environments (guideline 4);
- Management of pollution by shipping industry: Marine Pollution Control Legal and Managerial Frameworks (guideline 3);
- Regional guidance for waste and nutrients pollution management in the Wider Caribbean Region: Regional Action Plan on Marine Litter Management (RAPMaLi) for the Wider Caribbean Region 2014 (guideline 7) and Regional Nutrient Pollution Reduction Strategy and Action Plan for the Wider Caribbean Region (guideline 8).

Referring to **monitoring** guidelines and accounting also the waste monitoring experience in Belize presented by guideline 10, it is a general finding that OSPAR protocols adjusted for Caribbean setting (guideline 6) are a useful tool for the Wide Caribbean Region and Barbados to deal with several pollution issues. Guideline 2 provides selection criteria of monitoring approaches to account for resource/capacity constraints and details for monitoring litter in biota which can be useful in Barbados.

Guideline 4 can be useful to establish **beach water quality management** organized in recreational water safety plans, providing a set of relevant indicators.

Guideline 3 focus the framework for **action on sea-based pollution sources**, indicating that it is defined by international conventions/protocols, which Barbados is generally part of. However, it highlights the need to ensure regular surveys of ships and provide the required port reception facilities of material streams which can be otherwise dumped in the sea. The importance of these procedures for the prevention of marine pollution in the context of the Caribbean Region / SIDS is highlighted also in guidelines 7, 8, 10 and 12.

Finally, guidelines 7 and 8 provide important **orientation for waste and nutrients pollution under Cartagena Convention**, thus of relevance in Barbados as part of the regional effort, namely concerning review of legislation, policies and enforcement; monitoring and research; education/outreach; management strategies.

4.3. Selection of preferred solutions

Based on the discussion of the relevance in the context of Barbados of the methods, tools and practices reviewed, the following solutions are proposed to improve the marine pollution management process in Barbados (cf. Table 53 for relevant guidelines):

- Mainstream Draft Regional Strategy for the Protection and Development of the Marine Environment of the Wider Caribbean Region (UNEP/CEP, 2021a) and the SDG (UNDP, 2023) in the Barbados Marine Pollution Management Strategy's **Vision, Mission and Guiding Principles**, having as **priority pollution issues** marine litter and microplastics, wastewater, nutrients and sediments, ocean acidification;
- Prioritize marine pollution management per **hotspots** of ecosystem relevance and concentration of polluting economic activities, in which the several priority pollution issues are addressed;
- Adopt a general **10 step procedure** as framework to further develop the Barbados Marine Pollution Management Strategy, including as main steps:
    - Construction of a **conceptual model** for each hotspot, based on D2 – Situational Analysis (complemented if required with existing data and scientific literature), including: water processes, pressures (polluting economic activities) being managed and associated stressors, key ecosystem receptors;
    - Define **community values** and **management goals**, in alignment with relevant plans and policies of Barbados concerning ecosystems and water uses, such as Integrated Coastal Zone Management: The Barbados Policy Framework (2020-2030) (Coastal Zone Management Unit, 2020), 2020 Water Protection and Land Use Zoning Policy (Ministry of Energy and Water Resources, 2020), National Biodiversity Strategy and Action Plan 2020 (Government of Barbados, 2020), Barbados' Second National Communication – under the UNFCCC (Government of Barbados, 2018);
    - Define relevant indicators using multiple lines of evidence comprising **pressure indicators, stressor indicators and ecosystem receptors indicators**, encompassing the priority pollution issues for hotspots; consider available regular monitoring in Barbados and monitoring guidance;
    - Determine **guideline value and objective for each indicator**;

- Define **management strategies for land-based pollution**, mainstreaming relevant approaches for marine pollution management in the Caribbean and in other SIDS;
- Define **management strategies for sea-based pollution**, based on adequate port reception facilities for the management of sewage, waste and chemicals and in regular surveys of ship transport under MARPOL Convention and other relevant international conventions;
- Provide for **evaluation and review** of the Barbados Marine Pollution Management Strategy every 10 years, assessing all 10 steps in the methodology in an adaptative management approach;

- Develop the Barbados Marine Pollution Management Action Plan to implement the Strategy, comprising:
  - **Management actions** for each priority pollution issue and hotspot and transversal management action referring to research and education/ outreach: comprising timelines, milestones and responsibilities;
  - **Monitoring programmes to track improvements in management** actions;
  - **Monitoring programmes to track improvements towards quality objectives** of all indicators, one programme per priority issue (litter, wastewater, nutrients and sediments, ocean acidification);
  - **Evaluation** of action plan every year and **review** every 5 years.

Table 53 – Selected solutions from reviewed methods, tools and practices

Guidelines: **3** - Marine Pollution Control Legal and Managerial Frameworks; **4** - WHO Guidelines for safe recreational water environments; **5** - Marine Strategies for Portuguese Marine Waters / Madeira Islands; **6** - OSPAR Coordinated Environmental Monitoring Programme; **7** - Regional Action Plan on Marine Litter Management (RAPMaLi) for the Wider Caribbean Region 2014; **8** - Regional Nutrient Pollution Reduction Strategy and Action Plan for the Wider Caribbean Region; **9** - Western Indian Ocean Strategic Framework for Coastal and Marine Water Quality Management; **10** - National Marine Litter Action Plan for Belize; **11** - Australian and New Zealand Guidelines for Fresh and Marine Water Quality; **12** – Cleaner Pacific 2025 Strategy and Implementation Plan		
Solution	**Description of main components**	**Relevant guidelines**
Prioritize management per hotspots	• Hotspots defined by ecosystems and uses' sensibility and impacts concentration • Hotspot Committees: local management structure and stakeholders	7,8,9
Integrated adaptative marine pollution management process	• Stepped iterative procedure for generation of strategy and action plan • Conceptual model pressures, stressors and impacted values • Based on protection of community (ecosystems, uses) values and pursuit of management goals	9,11
	• Regular evaluation and review of strategy (every 10 years) and action plan (every 5 years) based on indicators	10,12
Assessing marine pollution based on pressure / stressor and receptor indicators	• Pressure: fertilizer use, % wastewater flows treated to national standards, per capita generation of municipal solid waste • Stressor: dissolved inorganic N and P, turbidity, intestinal enterococci (water and sand), macroplastics (over 5mm) and microplastics in beaches, pH • Receptor: Index of Coastal Eutrophication Potential, Chlorophyll a, number of shellfish beds and fisheries closures per year, number of illnesses from poor bathing quality per year, microplastics in subsistence biota (fish, molluscs)	4,6,7,8,10
	• Criteria for indicator suitability	9

Guidelines:
3 - Marine Pollution Control Legal and Managerial Frameworks; **4** - WHO Guidelines for safe recreational water environments; **5** - Marine Strategies for Portuguese Marine Waters / Madeira Islands; **6** - OSPAR Coordinated Environmental Monitoring Programme; **7** - Regional Action Plan on Marine Litter Management (RAPMaLi) for the Wider Caribbean Region 2014; **8** - Regional Nutrient Pollution Reduction Strategy and Action Plan for the Wider Caribbean Region; **9** - Western Indian Ocean Strategic Framework for Coastal and Marine Water Quality Management; **10** - National Marine Litter Action Plan for Belize; **11** - Australian and New Zealand Guidelines for Fresh and Marine Water Quality; **12** – Cleaner Pacific 2025 Strategy and Implementation Plan

Solution	Description of main components	Relevant guidelines
Management strategies for land-based pollution	• Establish/enhance litter wardens/patrols for enforcement of legislation • Web-based database as clearinghouse for marine litter information and research • Engage all stakeholders at community level in monitoring and research efforts on litter • Integrate issues of marine litter into formal educational curricula and programming • Research best practices in the hotel and restaurant sectors and strengthen collaboration with the tourism sector in sharing best and lessons learned • Circular economy approaches (materials recycling, composting, treated wastewater and nutrients reuse) • Review policy/legislative and institutional framework to identify gaps, weaknesses and barriers to Regional Nutrient Pollution Reduction Strategy • Incentive programmes for farmers and other sectors for nutrient management and wastewater treatment • Payment to farmers and landowners for ecosystem services • Training actions in micro and macro plastics	7,8,10,12
	• SMART (Specific, Measurable, Achievable, Realistic, Timely) for management strategy suitability	10

Guidelines:
3 - Marine Pollution Control Legal and Managerial Frameworks; **4** - WHO Guidelines for safe recreational water environments; **5** - Marine Strategies for Portuguese Marine Waters / Madeira Islands; **6** - OSPAR Coordinated Environmental Monitoring Programme; **7** - Regional Action Plan on Marine Litter Management (RAPMaLi) for the Wider Caribbean Region 2014; **8** - Regional Nutrient Pollution Reduction Strategy and Action Plan for the Wider Caribbean Region; **9** - Western Indian Ocean Strategic Framework for Coastal and Marine Water Quality Management; **10** - National Marine Litter Action Plan for Belize; **11** - Australian and New Zealand Guidelines for Fresh and Marine Water Quality; **12** – Cleaner Pacific 2025 Strategy and Implementation Plan

Solution	Description of main components	Relevant guidelines
Management strategies for sea-based pollution	• Adequate port reception facilities for the management of sewage, waste and chemicals • Regular surveys of ships	3
Action Plan Monitoring programmes to track towards quality objectives	• Action Plan	11,12
	• Monitoring programme for recreational quality, nutrients and sediments and ocean acidification	4,6,8
	• Monitoring program for litter and microplastics	7,10

5. Feasibility of introducing solutions into national plan-making process

5.1. Contents and overview

This chapter aims to assess the feasibility of introducing the solutions proposed in the previous chapter into the marine pollution plan-making process of Barbados (sub-task 3.3 in Work Plan for the Assignment).

5.2. Assessment of the level of implementation in Barbados

In this section the feasibility of the solutions proposed for the improving the marine pollution management in Barbados is assessed considering the Barbados' legal and regulatory framework, and the institutional and governance framework, as characterised in D2 – Situational Analysis.

Major challenges envisioned at the moment concern the solutions proposed and feasibility assessment are presented in Table 54. In general challenges identified relate to institutional resources, such as those concerning monitoring capacity and port reception facilities, but also to stakeholder buy-in of relevant circular economy approaches. Most of the challenges can be overcome with the adoption of specific approaches and therefore are considered feasible.

A few challenges are found to be not overridable, namely the lack of a microplastics laboratory and the lack of port facilities for the reception of chemicals, resulting in unfeasible solutions. Nevertheless, for these cases actions can be developed to improve future feasibility or provide alternative solutions.

These feasibility considerations are used to draw the recommendations for the development of the Marine Pollution Management Strategy and Action Plan of Barbados as presented in the following chapter.

Table 54 – Main challenges and feasibility assessment of marine pollution management solutions

Solution	Challenge	Feasibility Assessment
Hotspots	• Not defined	Feasible (with literature review and stakeholder consultation)
Conceptual model	• Limited data on water quality • Lack of marine litter data	
Expand set of monitoring indicators, including pressure and ecosystem receptors indicators	• Limited resources for monitoring • Lack of regular monitoring for marine litter, nutrients and ocean acidification • Lack of established guidelines in Marine Pollution Act	Feasible (use pressure and ecosystem indicators already in use in other management frameworks; define clear waste monitoring guidelines and involve NGOs and community in waste monitoring; limit indicators to a small set)
	• Lack of communication between sectoral institutions and environmental authorities (EPD, CZMU)	Feasible (mainstream monitoring requirements in sectoral reporting; create hotspot stakeholders committees to improve communication; mainstream monitoring requirements in environmental impact assessments of new developments)
	• Lack of microplastics laboratory	**Not feasible** (search funding and technical guidance for implementation of a microplastics lab in University of the West Indies / McGill University)
Circular economy approaches	• Resistance to waste separation • Resistance to use of compost and treated wastewater in agriculture	Feasible (with education/outreach of communities and stakeholders; create a recycling and composting association to increase communication between stakeholders)

Solution	Challenge	Feasibility Assessment
Ensure adequate port reception facilities for sewage, waste and chemicals from ships regulated by MARPOL	• No wastewater reception facilities	Feasible (implementation of an onsite wastewater treatment plant or connection to collective wastewater treatment plant)
	• No chemical reception facilities and no chemical disposal facility in the country	**Not feasible** (improve control surveying of ships)
Ensure regular surveys of ships regulated under MARPOL and other international conventions	• Limited human resources for surveying in CZMU	Feasible (coordinate with neighbour Caribbean states a schedule for surveying regulated ships)

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6. Recommendations to successfully integrate feasible solutions

Based on the identification of the feasible solutions to improve marine pollution control management, this chapter discusses how the preferred and feasible solutions can be effectively implemented into the marine pollution plan-making process of Barbados (sub-task 3.4 in Work Plan for the Assignment).

Work is accomplished through the design amendments and revision of plans and policies.

The following recommendations are found important to foster the development of the Marine Pollution Management Strategy and Action Plan of Barbados:

- Engage relevant stakeholders throughout the process. Communities, NGOs and private sector may play a critical role in the development of the Strategy and Action Plan due to its intersectoral nature to obtain buy-in and facilitate collaboration;
- Review legislative framework with its enforcement mechanisms and institutional framework, together with policies acting on marine environment, to identify gaps, weaknesses and barriers to the implementation of the strategy;
- Identify a key department and/or ministry responsible for coordinating efforts of all the actors involved in the Strategy and Action Plan;
- Define the hotspots for marine pollution management considering present water quality data availability, major pollution sources location and important ecosystem values and marine water uses; at present it is envisaged that hotspots could be defined by the coastal area of Bridgetown and the South Coast;
- Prepare for hotspot committees as stakeholders forums to achieve successful advancements and implementation of the Strategy and Action Plan. A concerted effort needs to be made to shape collaborative relationships between entities interested in local marine pollution;

- Mainstream the relevant multilateral environmental agreements in the Strategy and Action Plan to foster synergies. This should be actively pursued for the Sustainable Development Goals, the Cartagena Convention and Caribbean Environmental Programme framework documents, the MARPOL Convention, the United Nations Framework Climate Change Convention (UNFCCC), among others;
- Mainstream the relevant national policies and plans in the Strategy and Action Plan to foster synergies. This should be actively pursued for national Climate Chance mitigation and adaptation policies (National Communications under the UNFCCC) and national policies and plans relating to biodiversity, ecosystems and ecosystem services and marine environment livelihoods, such as fisheries and tourism sectorial plans, assisting the identification of community values and management goals (National Biodiversity Strategy and Action Plan (Government of Barbados, 2020), Integrated Coastal Zone Policy (Coastal Zone Management Unit, 2020));
- Search for relevant indicators in regional and international frameworks and other relevant national reporting frameworks, to ensure the use of available monitoring mechanisms. This should be specially fostered in the case of biological or ecosystem indicators, such as those gathered (UNEP, 2021) in the context of the Reef Health Index, other coral reef indicators, sea turtle monitoring and other indicators;
- Include climate change mitigation and adaptation considerations in assessing effectiveness of management strategies and actions;
- Contemplate research actions to deepen the knowledge base for emergent or complex issues such as ocean acidification and hazardous substances pollution, preparing the future improvement of the Strategy and Action Plan;
- Assess the opportunity to implement relevant pilot projects, which results can be incorporated in the updating of the Strategy and Action Plan;
- Pursuit regional cooperation in the Wide Caribbean Region to achieve funding and technical support for the implementation of the Action Plan;
- Operationalise and strengthen the personnel involved in the Strategy and Action Plan. Ensure that they have adequate resources and an adequate policy and legislative framework to perform their functions;

- In particular, reinforce and promote capacity building to expand and enforce monitoring programmes, including the preparation of adequate analytical equipment and skills (e.g. for microplastic analysis). Also, explore opportunities to conduct monitoring outside the EPD and CZMU, through collaboration with universities, the communities and the private sector, e.g. through environmental impact assessments and reporting requirements, promoting engagement and reducing costs;
- Include comprehensive communications activities, education/outreach programmes and public education campaigns aimed at raising the environmental consciousness of communities concerning marine pollution issues. Community-based education programmes are necessary to fully engage the general public in protecting their own marine environment and livelihoods;
- Promote education campaigns towards ecosystem services, to raise awareness on how human communities benefit from healthy ecosystems;
- Prepare for a single platform for knowledge management and e-learning serving all entities involved in the Strategy and Action Plan.

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7. Concluding remarks

Task 3 of the Consultancy for the *Development of a Marine Pollution Management Strategy and Action Plan in Barbados* consisted of the review and discussion relevance and feasibility of methods, tools and good practices for the improvement of the marine pollution management process in Barbados.

Twelve (12) guidelines were selected considering the requirements of the assignment and focusing world best practices and relevant approaches in tropical Small Island Developing States' context. They comprise: five guidelines concerning the development of marine pollution management strategies or action plans, one guideline focused on the management of sea-based pollution, four monitoring guidelines and two guidelines addressing specifically the framework for marine pollution management in the Wider Caribbean Region.

Most of the guidelines address specific pollution issues and only a few integrate several issues in the same framework. Several guidelines were found to present relevant solutions to improve Barbados' marine pollution management, considering the geographical, environmental and socio-economic context of the country.

To accomplish an integrated adaptative management process the Australian & New Zealand Guidelines for Fresh and Marine Water Quality (Commonwealth of Australia, 2018) and Western Indian Ocean Strategic Framework for Coastal & Marine Water Quality Management (UNEP/Nairobi Convention Secretariat; CSIR, 2021a) were highlighted. These guidelines can be complemented with focused approaches relevant in SIDS context by Belize Marine Litter Action Plan (Department of the Environment, 2019) and the Cleaner Pacific 2025: Pacific Regional Waste and Pollution Management Strategy 2016-2025 (SPREP, 2016).

Relevant approaches from guidelines were feasibility assessed considering the legislative/regulatory and the institutional/governance of Barbados and recommendations for implementation of the feasible solutions in the country's marine pollution management framework were presented.

The next step in the consultancy will involve stakeholder consultation of the findings of Task 2 and Task 3, particularly of the recommendations for the development of the Marine Pollution Management Strategy and Action Plan.

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