

A List of Priority Research Themes

The MASMA Programme as a regional programme, seeks to strengthen trans-disciplinary research by involving researchers from disciplines, different countries, types of stakeholders and sectors. The purpose is to increase the knowledge-base relevant to the welfare of coastal communities, society at large, and sustainable development through environmental management and governance. MASMA is also an innovative way to build new, and utilize existing human and research capacity to address coastal and marine issues and challenges. In addition, and in line with the overarching theme of the proposed Programme, MASMA provides the platform to address research needs to assist the countries of the WIO in achieving the SDGs.

The purpose of identifying research themes is to pinpoint key priorities for the next 3–5 years which can be used to guide calls for proposals for the MASMA Programme. It can also be used to inform the development of research strategies and funding programmes targeting other funders.

Priority Research Themes for the MASMA Programme are drawn mainly from the peer-reviewed World Ocean Assessment (WOA) and the Regional State of the Coast Report (RSOCR) for the WIO region. In both cases, these documents provided a synthesis of existing knowledge and baselines, but more importantly, trends in coastal and marine systems.

The WOA is the first global integrated assessment of the marine environment and it involved a combination of three approaches as the basis for structuring the Assessment. These are: the ecosystem services (market and non-marketed, tangible and intangible) that the coastal and marine environments provide; the habitats that exist within the coastal and marine environments, and the pressures that human activities exert on the coastal and marine environments.

The related and similarly structured WIO RSOCR performed an assessment of the relevant components pertaining to the marine and coastal environment. The analysis therein highlighted the main drivers of change and the consequential pressures that are exerted in the environment and human livelihoods, described current status and trends of natural and societal processes, and identified impacts.

The WOA identified the global gaps in knowledge and in capacity-building that hinder the appropriate responses to the challenges facing coastal and marine environment.

Priorities identified in these two key documents are in agreement with those identified by different regional outputs:

- i) Strategic Action Programme for the Protection of the Coastal and Marine Environment of the Western Indian Ocean from Land Based Sources and Activities (2009);
- ii) Transboundary Diagnostic Analysis of Land Based Sources and Activities Affecting the Western Indian Ocean Coastal and Marine Environment (2009);
- iii) Transboundary Diagnostic Analysis for the western Indian Ocean. Volume 1: Baseline (2012);
- iv) Transboundary Diagnostic Analysis for the western Indian Ocean. Volume 2: Diagnostic Analysis (2012);
- v) Regional Strategic Action Programme (SAP) for the LMEs (2012);
- vi) Science Plan, 2017-2021 for the Nansen Programme (2016);
- vii) Climate Change Strategy for the Nairobi Convention (2016);

- viii) A Case for Marine Spatial Planning in the Blue Economy of the Western Indian Ocean (2017); and
- ix) Science Plan, 2015-2020 for the Second International Indian Ocean Expedition for WIO region.

An analysis of knowledge gaps identified by outputs can be summarized in ten themes. These are also used here as the basis of the priority research themes for the MASMA Programme.

I. Impacts and mitigation of the risks of climate change

Climate change impacts will affect both natural and human systems in WIO coastal and marine environments, in many cases amplifying existing anthropogenic threats (non-climate stressors) and thereby further prevent effective management of these resources. The impacts of climate change cuts across all other themes. The main climate change impacts of concern are: higher surface and sea temperatures; extreme events such as droughts, floods, and severe storms; increased precipitation variability including variations in annual rainfall, timing, duration, frequency, and intensity; sea level rise; and ocean acidification.

At the regional level, WIO countries' priorities and needs in the area of climate change are reflected in a number of documents such as the Climate Change Strategy for the Nairobi Convention. Further, priorities and needs are also drawn from national plans, the outcomes of the UNFCCC Conferences of the Parties (such as Paris Agreement) and the outcomes of related international meetings.

The Strategy provides a roadmap for the Nairobi Convention Secretariat together with contracting parties to address the impacts of climate change. It describes key results and objectives to guide actions under four integrated components: climate change adaptation on political agenda, climate change policy formulation, adaptation policy implementation, and adaptation monitoring and evaluation.

Proposed research topics can be drawn from the Strategy; particularly from:

- Strategic Outcome 2: Improved Decision Support to Policymaking
 - Key Result 2.1 - Improved understanding of the ecological impact of climate change
 - Key Result 2.2 - Improved understanding of the vulnerability of coastal communities and also of people not living in the coastal zone but being dependent on flows of goods and services from coastal systems
 - Key Result 2.3 - Climate change information and knowledge is effectively communicated
- Strategic Outcome 3: Adaptive management approaches that will result in the implementation of climate change adaptation is supported
- In addition, and given the inevitable changes that are likely to occur in many coastal and marine ecosystems under climate change, an increased understanding of the potential future changes in ecosystem services that humans will need to adapt to is essential to ensure management for sustainable coastal communities and their economies.

II. Socio-ecological approaches for the sustainable use of marine living resources

The WIO region is characterised by high biodiversity attributed to equally diverse habitats available to marine organisms. These include mangrove forests, estuaries, seagrass meadows, coral reefs, soft sediments and inshore banks, deep incised canyons, sea mounts, amongst others. In many cases these habitats support extraction of living resources, either targeting species within those habitats or harvesting species that have some dependence on these habitats. Such fisheries may affect the

intricate interactions between species and the very habitats on which they are reliant for their survival.

The living resources of the WIO region are subjected to a number of negative impacts which place them at differing levels of risk. The impacts arise from factors including ecosystem and habitat destruction, climate change and fishing, including targeted fishing or as bycatch. Fishing is also impacts on the species' environment in some instances. Coral reefs, mangroves and seagrass beds are critically important tropical habitats in the region. They provide habitat and other services for coastal species and for coastal human populations which depend on them for food, livelihoods and other ecosystem services. These habitats are under threat from a range of human impacts including pollution, sedimentation, physical removal, human settlement and the damaging effects of fishing. Whatever the case, some species are more vulnerable than others and these require identification and protection. The best available estimates are that at least one third of marine fisheries resources are fully or overexploited particularly in nearshore waters.

Proposed research topics include:

- Development of methods and tools for the elucidation of levels of the known impacts of concern in target habitats, ecosystems, and on species known to be key to natural systems sustainability and the security of human welfare in coastal communities.

III. Aquaculture development, food security and food safety

Fish are a central component of dietary protein in most WIO communities. Coastal inhabitants rely heavily on fishing as a source of food and income, and over many centuries fishing has become part of local culture and customs.

Currently the WIO generates a catch of more than 4 million tonnes of fish per year comprised of catches from traditional subsistence and artisanal activities using a wide variety of different gears, as well as large-scale industrial operations fishing mainly with longlines, purse seine nets and trawling.

Artisanal fisheries typically utilise small craft in nearshore waters, whilst industrial fisheries operate further from the coast using ocean-going fishing vessels and high technology fish location technologies. A third and significant fishery is that of migrant fishers. Migrant fishers follow fish movements along the coast as part of a socio-economic adaptation to a complex environment. Once landed, the processing and trade of fish catches at local markets are important economic activities, often performed by women. In this context, fisheries represent a key activity with influences across socio-economic, gender, and other important social spheres.

Because of concern over the sustainability of natural fish stocks, there is growing emphasis across a number of WIO countries on the development of the aquaculture industry for meeting food security and income generation goals. However, aquaculture expansion cannot be envisaged in isolation from other sectors. Many of these countries share common coastal resources that are the foundation for livelihoods and are interconnected to, and influenced by, aquaculture expansion. Further, aquaculture development brings with it new or increased pressures on marine and other ecosystems that can have far reaching ramifications for the long-term sustainability of the natural environment and the industry itself.

Proposed research topics include:

- How to strengthen fisheries and resource management through implementation of Ecosystem Approach to both Fisheries (EAF) and aquaculture (EAA) to meet both socio-economic and conservation objectives
- Maximising the social and economic values of the catch (wild caught and farmed) by reducing post-harvest losses and understanding the value chain at a local and regional level.
- Generation of improved tools that better underpin site selection and enabling sustainable and equitable aquaculture integration in the larger socio-ecological system.
- Improve, develop and pilot test production model(s) demonstrating and/or improving the economic, social and environmental viability of farmed species out from a broader equity perspective.
- Investigate rational pathways for nutrition sensitive aquaculture that provide nutrition to poor people.
- Investigate and promote coastal aquacultures able to strengthen the involvement and influence of women.

IV. Understanding biodiversity and its change

The WIO region is characterised by high biodiversity; both in terms of species and ecosystems. This makes the WIO one of the most rich and interesting ocean regions of the world. Accordingly, a large fraction of the coastal population in the region is dependent on coastal and marine resources and ecosystem services. It is apparent that marine and coastal ecosystems in the WIO region are in a reasonable condition, although they are under direct and indirect increased pressures through resource exploitation and other anthropogenically-driven habitat degradation. The effects and impacts of global climate change add further pressures to locally-acting sources of disturbance.

Proposed research topics include:

- Assessments of biodiversity value at locally/regionally appropriate scales to underpin the management & protection of vulnerable areas and recognized biodiversity “Hot Spots”.
- Connectivity of ecosystems and its biodiversity.

V. Approaches for the sustainable uses of ocean space

Increased use of ocean space, especially in coastal areas, creates conflicting demands for dedicated marine space and land use. This arises both from the expansion of long-standing uses of the ocean (such as fishing and shipping) and from newly developing uses (such as hydrocarbon extraction, mining, the generation of renewable energy conducted offshore and mariculture). In most cases, these various activities are increasingly implemented without any clear overarching management system or a thorough evaluation of their cumulative impacts on the ocean environment; thus increasing the potential for conflict and cumulative pressures.

The coastal and marine environment of the WIO region offers much opportunity for the beneficial and sustainable use of natural resources. Equally so, the unsustainable use of resources threatens livelihoods, human well-being, and the biodiversity that is the basis for ecosystem goods and services. Most of the countries in the WIO region are experiencing expansion of traditional uses of the ocean (such as fishing, tourism and shipping) and development of new ones (such as

hydrocarbon extraction, mining and aquaculture). All these are leading to conflicting demands for marine space.

Marine Spatial Planning (MSP) is an emerging public policy process for the allocation of marine space over time that aims to achieve ecological, economic and social objectives that are defined by a political process. MSP has shown great promise if built on a foundation of reliable and objective information, coupled with appropriately (multi-) scaled governance and institutions.

Proposed research topics include:

- A review of current spatial planning methods, approaches and strategies in the WIO region;
 - Identify gaps – technical, skills, knowledge, methodologies, and data;
 - Identify barriers to the development of an integrated approach to spatial planning for marine resource use and exploitation at relevant local, national, and regional scales;
 - Review of spatial planning policy, strategic planning, and implementation processes in other maritime countries to identify how the above knowledge can be best utilized in policy and implementation in the WIO.
- Development of ecosystem-based tools and approaches for marine spatial planning
Integration of regional area-based management tools to reduce cost and conflict, and increase the achievement of sustainable development goals

VI. The threats from increased pollution

The WIO-LaB Transboundary Diagnostic Analysis (TDA) identified the main transboundary problems in the region related to land-based sources and activities as (i) Water and sediment quality degeneration due to pollution from land-based sources and (ii) Alteration in freshwater flows and sediment loads from rivers. A significant amount of the pollution load in the WIO Region emanates from land-based activities such as municipal and industrial effluents, contaminated surface run-off, as well as groundwater and agricultural return flows. In most WIO countries, contaminants from land-based activities are disposed of in the coastal zone where they affect some of the most productive coastal and marine ecosystems, such as mangrove-fringed estuaries, coral reefs, tidal creeks and near-shore waters. Moreover, contaminants which pose risks to human health and living organisms can be transported long distances by watercourses, ocean currents and atmospheric processes. The TDA identified five distinguishable priority pollution categories in the region, namely: Microbial contamination (bacteria and virus), Suspended solids, Chemical pollution, Marine litter (including debris), and Eutrophication (harmful/nuisance algal blooms emanating from nutrient elevation).

Increasing volumes of debris and litter, is known to cause major impacts on ecosystems and fishery resources. A new threat to marine life is microplastics, formed by deterioration of plastic debris into tiny particles. Microplastics have been shown to enter the marine food web via plankton, but their effects, as well as the effects of different pollutants such as heavy metals on seafood and more generally on marine ecosystems have been poorly documented in the WIO region.

Proposed research topics include:

- Short and long-term cumulative effects of physical, chemical, and biological contaminants on marine ecosystem functions and human well being

- Innovative monitoring techniques and indicators to characterize more precisely the sources and input pathways of nutrients and other pollutants, with special focus on development of water and habitat quality indicators based upon emerging marine biotechnology tools and capabilities
- Models for assessing the effects on water quality of nutrients and toxic pollutant discharges specific to particular land use practices
- An assessment of the level of micro-plastic in coastal waters and their impacts on marine organisms
- An assessment of the level of heavy metal contamination in the WIO, and impacts on marine organisms and people's health via seafood consumption.
- Alternative low-cost technologies to deal with pollution management and control.

VII. Cumulative impacts of human activities on marine biodiversity and its importance for ecosystem functions and services

For the WIO countries, the most important concern for the future is the maintenance of biological diversity and the ecological function of coastal and marine environments. This is seen as being central to meeting production levels for human food supply, and fundamental in protecting the biodiversity on which future productivity depends. Concomitantly, this is also key to the development of strategies to resolve conflicts and address threats to resources and the environment in general.

Coastal and marine environments are dynamic multidimensional entities, comprising both natural (physical, chemical, biological, etc) and social (institutions, knowledge, perceptions, economic and cultural values, etc) processes. Consequently, the dynamics of the coastal and marine environments are controlled by the interactions and feedback mechanisms between natural and social processes. Therefore, it is important that these interactions and feedbacks mechanisms are well understood as a prerequisite for sustainable management of coastal and marine resources.

Proposed research topics include:

- Influences of societal processes such as governance and food security, at local, national, regional and global levels, on the health of coastal and marine ecosystems
- Society's use of natural resources and how this has changed with the development of and changes in consumption patterns, production systems, technology, and political actions
- An analysis of benefit and cost flows, and major existing and potential conflicts within port environments, with a focus on identifying significant commonalities and differences between the various port-urban centres
- An understanding of the key social, economic and environmental interdependencies in the region that are affected by port development and operations. For instance, how are coastal resources in port environments (or on coasts near ports) used? What species are harvested? By whom? How are they affected by port development and operation? Information relating to port water quality. Are ports polluted? How? With what? Is this due to port related activities or surrounding socio-economic development or both?
- The generation of causal loop and systems dynamics models of critical interacting agents and processes for use in decision support and strategy development.

VIII. The socio-economic dynamics of inequality: the distribution of access to and benefits from coastal and marine resources

The WIO region offers a wealth of opportunity for the profitable and beneficial use of coastal and marine resources. These extractive and non-renewable resources hold significant value for a number of different sectors of the economy, such as fisheries, forestry, tourism, shipping, fossil fuels, aquaculture and mining, which supply expanding local, national and global consumer markets. Although these activities provide opportunities for economic and income growth, global patterns indicate growing levels of economic inequality between the custodians of coastal resources and those who exploit them. This is concomitant with an increasing incidence in absolute levels of poverty, particularly amongst coastal communities where the minimal income required for basic needs such as food, shelter, health care and clothing is not available. Moreover, many coastal communities remain politically and economically marginalized, which leads to conflict over access to the resources and benefits of the coast.

Proposed research topics include:

- Understanding of poverty dynamics, the pathways into and out of poverty, and how poverty influences the ways people use a range of ecosystem goods and services
- Understanding dynamics of livelihood diversification. These are poorly understood and many alternative livelihood projects have demonstrated very low levels of sustainability
- What are the main 'drivers', in particular with respect to macro-economics, which lead to unfair trade models, including those between WIO countries and the global community?
- Access to the coast and its resources, particularly in relation to private interests and tourism
- Trickle down of benefits from coastal activities.

IX. Integrated management and governance of human activities affecting the coast and ocean

Different management regimes have been adopted for managing coastal and marine resources in the countries of the region. These include traditional management systems, collaborative management arrangements and enforcement of policies and laws through various regulatory mechanisms. Frequently these management regimes have been designed for the achievement of social, economic or political goals, without equal consideration of sustainable societal and environmental development. There are several characteristics that are critical for the legitimacy and efficiency of resource management regimes. These include: clarity and transparency of national and local laws and regulations, involvement of concerned stakeholders in decision-making processes, mechanisms for optimal use of knowledge and science in decision-making processes (including local/traditional knowledge), clear regulations addressing obligations and rights, including tenure rights to the resources, access rights, and rights of users to devise their own institutions (that take into consideration traditional knowledge and customary law). Equally important for robust governance regimes is to find an appropriate balance between positive incentives and negative sanctions, improve openness of governance, and form appropriate structures for implementation. Research on management regimes and aspects related to them, gender aspects, and perception of stakeholders of sustainable use and management of such resources, is important for designing governance systems capable of creating social and ecological sustainability and equity.

Proposed research topics include:

- Assess effectiveness, efficiency and accountability of policies and legislation of marine and coastal resources at all levels (village, municipal and national levels)
- Assess the policy development process and how stakeholder values are dealt with in the process
- Environmental and social justice certification of fish and fish products: who gains, who loses, and what are these gains and losses?
- Strengthening sub-national policy process and implementation in increasing decentralized government
- Creating and testing approaches for more responsive evidenced-based coastal and marine policy processes aligned with achieving the SDGs
- Developing approaches for the integration of coastal and marine governance across domains (ICM, MSP, MPAs, EBSAs) and across natural and national boundaries.

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X. Finding mechanisms that speed up implementation of evidenced-based solutions

Degradation of coastal and marine environments has continued in many parts of the world including the WIO region, often without actions being taken even when adequate data and information exist or where techniques exist and have been used successfully elsewhere in similar contexts. The question is how to facilitate action to address known challenges in the cases where some of the solutions may also be known?

Proposed research topics include:

- Undertake a “systems” style analysis through case studies of the implementation process for policies and initiatives to:
 - Identify key barriers to uptake and assimilation by stakeholder groups;
 - Identify opportunities for innovation and the development of new approaches to mainstreaming of policies, technologies, and paradigms.