Data and Tools

Strengthening regional regulatory frameworks and national capacity for handling marine biodiversity data in the Western Indian Ocean

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Summary

Decision-makers need readily-available and accurate biodiversity data to make informed decisions concerning marine ecosystems' protection and sustainable use. This data is often generated by a multitude of unrelated stakeholders with sometimes diverging agendas. In congruence with limited data sharing, this can lead to a duplication of efforts and waste of precious financial and human resources. Eastern African countries' oceans and coastal areas are home to abundant marine biodiversity, with immense ecological and socioeconomic value. Stakeholders have varying interests concerning shared ecosystems. Transboundary conservation goals, marine spatial planning efforts, and harmonised coastal management strategies are of great value for sustaining ecological services for future generations and addressing potential spatial conflict conflicts. For sound coastal governance, decision-makers require access to accurate, current, and comprehensive data on the status of marine biodiversity to act on pressing environmental issues. However, marine biodiversity data may only be partially available for various reasons, including inaccessibility of unpublished or restricted data, dispersed storage locations, or legal requirements preventing the open sharing of data. Under these circumstances, effective data sharing is a most important issue and should be prioritised by policymakers and entities involved in research. Our recommendations are based on the outcomes of several expert workshops, qualitative interviews, and the extensive experience of involved partners in East Africa. Firstly, we propose to align biodiversity and taxonomic data collection, reporting and sharing through common frameworks. Monitoring efforts and data sharing across institutions and borders can be streamlined by creating regional sharing protocols and policies. Additionally, we suggest the installation of a regional inter-sectoral (ie academia, government, policymakers, industry, traditional knowledge holders) expert panel on marine biodiversity information needs and handling/sharing strategies. We recommend that national governments start this process by designating representatives for the proposed regional inter-sectoral expert panel. Those representatives would ideally be part of existing initiatives like the Nairobi Convention Clearinghouse Mechanism or the National Focal Points of the Convention on Biological Diversity. Through regular exchanges, this community of practice could co-design the necessary regulatory frameworks on best practices regarding data collection protocols, sharing agreements and training efforts.

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Background

The ocean is human's most important life-support system. It produces 50% of the oxygen we breathe, supports essential food sources, stabilises the climate and economically supports an immense marine and maritime industry (OECD, 2016). Oceans and coastal areas along the Eastern African shorelines are among the most diverse and productive marine ecosystems worldwide (Obura, 2012). They carry enormous ecological and economic value and help secure the livelihoods of millions of coastal inhabitants (Allison and others, 2009). As natural calamities, climate change and human pressures increase, species extinction or reduction in population is likely to be high in WIO countries, with potentially adverse effects on ecosystem services (Selig and others, 2014). Sustaining the ecological services for future generations and addressing potential competing interests about spatial use as part of sound coastal governance requires careful management of those often fragile ecosystems, especially since stakeholders have different interests concerning the use and protection of marine ecosystems (Pendleton and others, 2020). Fundamental to evidence-based management is the availability of information and data, which can now be generated at an incredible rate through a manifold of initiatives monitoring, scientific studies, citizen science, open-source technology, satellite and other remote sensing efforts (UNESCO, 2017).

There are now many opportunities to expedite providing biodiversity data to relevant decision-making institutions at a much faster rate than previously known. Our ability to model and predict changes in ocean systems and biospheres has also made significant progress. However, despite all the advances in data science, it is still challenging to get hold of the data and get results in the decision-maker's hands in a relevant and helpful format to make sustainable management decisions. There are technical and logistical constraints, institutional and governmental policies, missing scientific capacities or general issues in knowledge sharing that hinder the collection and sharing of in-situ biodiversity data. Additionally, especially in the case of biodiversity data, expert taxonomy knowledge is missing in many geographic areas, which leads to unwanted dependencies from external experts. Existing marine worldwide operable databases are frequently only useful as references but may not provide practical knowledge at national operational levels for individual habitat or coral reef management. Here, viable and usable marine species and biodiversity databases relevant at the regional to the national level are missing as decisions need local information and integration on the broader biodiversity context. To meet future conservation and management goals, we will need to identify common monitoring strategies and agree on the essential variables (biodiversity and taxonomic data) that should be observed and routinely exchanged and shared. Through actions like this, Africa could take the lead in increasing the pace at which scientific and monitoring data is being made available in a usable way to decision-makers and other interested stakeholders. To provide data for evidence-based decision-making, all sectors and processes, such as policymakers, scientists, local communities, small-scale fisheries, tourism, or the maritime sector, must be addressed. In the end, there will be no proper management without the correct measurements. Therefore, the proposed framework addresses several central themes of the Nairobi Convention Science-to-Policy Platform, including informing MSP efforts and data management and standardised monitoring efforts to simplify ecosystem monitoring and ecosystem approaches to fisheries.

Advances

Timely and accurate biodiversity data is essential for informed and science-based decisions concerning marine resource use and sustainable extraction of marine resources. It is also crucial in potential risks to coastal ecosystems by development projects, as exhaustive and encompassing biodiversity information is necessary for decisions regarding, eg the designation of shipping lanes and other use areas. All coastal and marine spatial planning efforts rely on information concerning marine biodiversity.

Biodiversity data is generated and used by a multitude of stakeholders and institutions. Resource management, such as park and fisheries authorities, need data for immediate management decisions and long-term planning efforts. When they notice environmental changes and must react accordingly to avoid or mitigate damage (ie during coral bleaching or pollution events) and supervise subsequent restoration and recovery, recent and readily available biodiversity data can facilitate the allocation of resources and set priorities. Small fishing communities that autonomously manage parts of their coastal areas also rely on that data, eg on stock assessments and habitat status. In policy and decision-making, processed data that presents comprehensive and summarised information

on biodiversity issues is needed to inform decisions and new policies on all levels. Ideally, this information is up to date and readily available.

Similarly to resource managers, policy and decision-makers may not be trained or have the time to analyse complex scientific studies. Instead, they require condensed and timely findings informing their decisions to identify conservation priorities, address conflicts, and shape legislation. At the regional level, policymakers use biodiversity data for regional ocean governance, ie creating strategies to manage and conserve transboundary marine ecosystems. Scientific projects generate primary data and knowledge per the proposed project details. Moreover, access to data collected in other projects may help them conduct further analyses or validate previous findings. While processed or metadata may be sufficient to support specific scientific questions, some researchers may depend on access to primary data, which allows for a greater variety of scientific and practical applications.

Additionally, there are monitoring efforts that government institutions regularly conduct to meet national or international reporting needs. Non-governmental organisations also frequently collect monitoring data for outreach and campaign activities. Despite international efforts, few regional regulatory frameworks regarding biodiversity monitoring, data management, and data sharing are currently in place. Besides, there are many pressing issues in biodiversity data handling and sharing that have not been resolved yet. These issues are not restricted to Africa, but the IOC-UNESCO Decade of Ocean Science for Sustainable Development and initiatives such as the UNEP Nairobi Convention offer excellent opportunities for African partners to be at the forefront in solving them.

It is mandatory to integrate existing initiatives into strengthening regional regulatory frameworks and national capacity for handling marine biodiversity data in the Western Indian Ocean. To prevent paralleled efforts, it will be crucial to identify already drafted or developed topics, standards and policy ideas that apply to the region and modify them to the needs of the Western Indian Ocean. It is also noteworthy that many commemorated efforts have been made in the region to improve the uptake of scientific biodiversity information into political decision-making processes.

The Nairobi Convention Clearinghouse Mechanism acts as a 'data reference centre' in the Western Indian Ocean region to provide accurate and relevant data and information for improved management and protection of the coastal and marine environment in the region. It will be one of the main aims of the present proposal to support the Clearinghouse activities in its efforts. All activities proposed here should be conducted in close cooperation with the Nairobi Convention. The recently instated Marine Spatial Planning (MSP) technical working group can facilitate the integration of biodiversity data and best practices into MSP decision support systems (eg WIOSym). This proposed framework can supplement essential biodiversity data.

Additionally, regional and global databases have large datasets on the WIO region (eg: Ocean Biodiversity Information System, OBIS; Tanzania Biodiversity Information Facility, TanBIF; Global Biodiversity Information Facility, GBIF). Those databases are important institutions in developing regionally binding standardised monitoring frameworks and sharing standards, such as the Darwin Core, and developing and maintaining the taxonomic expertise in the region. They are also essential in generating ideas on how to integrate traditional and indigenous knowledge into those efforts.

Regional regulatory frameworks and national capacities for handling marine biodiversity data in the Western Indian Ocean, developed in a participatory process while respecting the needs of all involved stakeholders, will streamline the flow of biodiversity information into decision-making processes as well as support national reporting goals such as the National Biodiversity Strategy and Action Plans (NBSAP) or international initiatives such as the Sustainable Development Goals (especially SDG 14). They will also support any eventual follow-ups to the Aichi targets and the Convention on Biological Diversity post-2020 biodiversity strategy. The IOC-UNESCO Decade of Ocean Science for Sustainable Development also offers an excellent opportunity to advance this topic, as data acquisition, handling, and provision are key aspects of any efforts under its banner.

Regional and global outlook

The overall aim is to develop a roadmap vision for the Western Indian Ocean region to become a model region for monitoring, handling, and sharing marine biodiversity data for sustainable resource use in support of the Nairobi Convention and its member states (Figure 1).

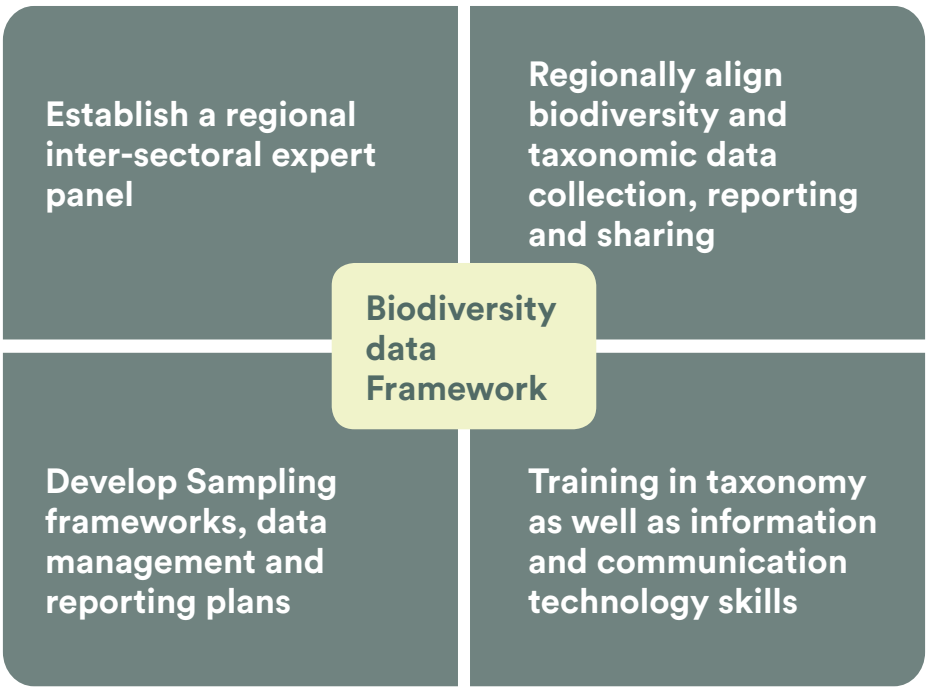

Figure 1: Main technical and policy recommendations towards and improved regional biodiversity data handling framework

Technical recommendations

We propose establishing a regional inter-sectoral (ie academia, government, policymakers, industry, traditional knowledge holders) expert panel on marine biodiversity information needs and handling/sharing strategies. This could be achieved through an exchange platform for policymakers and researchers to co-design and co-implement projects and discuss data needs for adaptive and timely management solutions. First, the established panel could create a database of experts and identify and register a review body on internationally accepted research and monitoring methods. It would also develop the underlying concepts, observed variables, data collection methods, sampling frameworks, and data management and reporting plans. Once concepts and frameworks are agreed upon, those can be rigorously tested in identified model regions. As a continuous effort, the panel can also support the development of technical, taxonomical and methodological capacities of researchers and decision-makers in and from within the region.

Policy recommendations

Regionally align biodiversity and taxonomic data collection, reporting and sharing through common frameworks. Monitoring efforts and data sharing across institutions and borders can be streamlined by creating regional sharing protocols and national data sharing policies based on proven and internationally recognised standards. Formal sharing agreements with governments and project donors could make timely data sharing a provision for issuing research permits or granting funds to increase reporting to national bureaus of statistics, local communities, or other data users. Aligned reporting mechanisms to assess and track developments in coastal ecosystems are indispensable to evaluate investments, monitor changes, and inform policy- and decision-makers. Those protocols, frameworks and policies should be co-designed to reflect the information needs of a broad spectrum of stakeholders and to be inclusive of under-represented status groups. Regionally aligned biodiversity and taxonomic data collection, reporting and sharing, would also benefit from increased data visibility in the region and streamlined pathways to exchange data and data needs. Given the multitude of organisations involved in ocean management and resource use, robust coordination mechanisms, eg through the Nairobi Convention or the established expert panel, enable science-policy interactions to help prepare society to respond to a regional change in marine ecosystems. Through focal points, such as the Nairobi Convention, efforts and incentives towards effective data communication can be implemented to increase the comprehensibility of research findings.

Workshops should train scientists and data collectors in effective sharing methods, ie compelling narratives, visual tools, field trips, or storytelling techniques. Furthermore, extensive training and capacity-building in taxonomy and information and communication technology skills should be funded and provided for individuals and entities handling marine biodiversity data. It is encouraged to seek alternative funding pathways, eg through public-private partnerships.

We recommend that national governments start this process by designating representatives for the proposed regional inter-sectoral expert panel. Those representatives would ideally be part of existing initiatives like the Nairobi Convention Clearinghouse Mechanism or the National Focal Points of the Convention on Biological Diversity. Through regular exchanges, this community of practice could co-design the necessary regulatory frameworks on best practices regarding data collection protocols, sharing agreements and training efforts under the advice of the identified regional panel of experts.

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Overview of oceanographic data and research for improved ocean governance in the Western Indian Ocean Region

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Summary

Oceanographic and other ocean-related research is critical for informing effective ocean governance. Informing the ocean policy requires multi-faceted research and an assortment of data and information. Every country in the Western Indian Ocean (WIO) region has national institutes that carry out ocean science research in national waters, covering all aspects of ocean science, including physical and chemical oceanography, habitats, biodiversity, ecology, and pollution. National datasets are not always readily available on online platforms and are generally scattered over many national institutes. Access to these datasets should be through national or regional data centres. Technological advancement and capabilities of the national data centres vary among countries. These centres face several challenges, including a lack of financial resources and adequate human capacity. While infrastructure is a challenge in most countries, improvements can be made to these centres but not necessarily to the same level in every country. It is recommended that the Contracting Parties of the Nairobi Convention request the Secretariat to support the strengthening of National Data Centres to collect, analyse and share data and information in the region. Such support may include preparing an action plan for the further development and support of National Data Centres under the SAPPHIRE Project; supporting capacity development initiatives aimed at strengthening the capabilities of the National Data Centres; and ensuring linkages between National Data Centres and regional mechanisms, such as the Nairobi Convention Clearinghouse Mechanism, ensuring efficient and effective sharing of regionally-relevant information.

Background

Ocean governance underlies the concept of Sustainable Ocean Economy, which is one of the desirable outcomes for the UN Sustainable Development Goal 14. Innovative and improved ocean governance requires essential data and information obtainable only from oceanographic and other ocean-related research. In line with the ecosystem approach to managing natural resources, ocean governance requires consideration for the ecological assets, the social and economic consequences of management actions, and regulatory agencies' ability to achieve management objectives in the face of external impacts. This requires multi-faceted research and an assortment of data and information.

One of the recommendations from the Second Consultative Meeting on the Development of African Strategy for Ocean Governance, held in October 2020, is that scientists and researchers should play a role in ocean governance. In addition, each state should designate a national science and research institute for the blue economy and ocean governance to undertake research and gather and analyse data to inform policy dialogues, formulation, and implementation. It was proposed that the African ocean governance strategy should include articles on the collection, aggregation and use of Africa's data on the oceans. Establishing an African oceanographic research/data centre or a network of national oceanographic research/data centres is also envisaged. This is in line with the Nairobi

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Convention Conference of Parties decision CP 4/8 on enhancing access to information. The Contracting Parties resolved to develop and/or organise outreach, knowledge and public awareness programmes on marine and coastal issues in collaboration with partners in the region.

Long-term monitoring of natural resources is vitally important for understanding the complex ecological processes that enable ecosystems to function (Likens 1989, Strayer and others, 1986). For scientists and managers to effectively determine reference points and baselines against which changes in the ecosystem can be measured, how the systems respond to management interventions, and the external influences such as climate variability and change, adequate and suitable data on essential ocean variables is indispensable (Likens 1989). The importance of long-term monitoring at the scale of large marine ecosystems was acknowledged during the Agulhas and Somali Current Large Marine Ecosystem (ASCLME) Project. Data centres were established to house data collected by each contributing country during the project's life (ASCLME 2009).

For the regional stocktaking workshop on oceanographic research and data in the WIO Region held in Mauritius in May 2019, some working documents were prepared. These included Koranteng and Everett (2019a), (2019b), and (2019c), which detail the status of data and approaches to the long-term monitoring of oceanographic data and scientific research in the Western Indian Ocean. Here, we consolidate the essential messages in the three reports necessary for the science to policy discourse.

Advances

Assessment of oceanographic data and scientific research in the WIO region

Every country in the Western Indian Ocean (WIO) area has national institutes that carry out ocean science research in national waters, including collecting oceanographic data and other ocean data necessary for good governance. These include government-funded research institutes, university departments and schools, and non-governmental organisations (Figure 1). Notable among these are the Mauritius Oceanography Institute (MOI), the Seychelles Fishing Authority

Figure 1. A schematic of organisations undertaking research in the Western Indian Ocean and the products that they produce. (Adapted from UNEP-Nairobi Convention and WIOMSA 2015)

(SFA), the Kenya Marine and Fisheries Research Institute (KMFRI), the Tanzania Fisheries Research Institute (TAFIRI), the National Fisheries Research Institute (IIP) of Mozambique, the Council for Scientific and Industrial Research in South Africa, the Institut Halieutique et des Sciences Marines of the University of Toliara (Madagascar) and the Oceanographic Research Institute (South Africa).

The research institutes work in the following major disciplines: fisheries science and management, oceanography, ecology, and primary production. A few also look at socio-economics, ocean governance, and recent issues related to the blue economy. While some institutions collect data for the region, it is more common for national institutions to collect and store data on a national or smaller scale. Presently, there is no regional-scale data collection undertaken by the WIO countries. Researchers and decision-makers must rely on external data sources such as satellites operated by American and European space agencies or research vessels outside the region. Two recent exceptions were the ASCLME and the South West Indian Ocean Fisheries Project (SWIOFP), both of which included all the countries of the WIO except Somalia that had observer status due to the political situation in that country at the time. These and other collaborative initiatives collect data for a specific period and/or area.

Many institutions collect oceanographic data globally, mostly remotely through satellite technology or buoys either moored or drifting. Two of these that hold a substantial amount of data for the WIO region are the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA), both of the United States of America. There are also initiatives that work on regional scales; key among these are the EAF-Nansen Programme and the Institut Francais de Recherche pour l'Exploitation de la Mer (IFREMER) of France. Both these initiatives include the use of research vessels in their data collection. The vessels are highly sophisticated and collect many data as they work in countries within the WIO.

Oceanographic data collection in the WIO is carried out on various platforms, including satellites and research vessels, using instruments ranging from shipboard equipment through electronic sensors on automated vehicles to Niskin and Nansen reversing bottles, Secchi disks and other basic tools and implements. Many research institutes monitor Essential Ocean Variables (EOVs) required to establish and assess ocean mean-state and variability.

Available relevant datasets and their management

National datasets cover all aspects of ocean science, including physical and chemical oceanography, habitats, biodiversity, ecology, and pollution. Oceanographic data for a particular country are usually not stored on one server in one locality. Data and samples from regional surveys may be kept or processed at several institutes. In addition to national data, there are many relevant datasets available to researchers in the WIO region; these have been tabulated in Koranteng and Everett (2019a). The datasets differ in their scale, the collection platforms, the sensors used, and the amount of post-collection processing done. The other datasets are generally large and complex, necessitating substantial capital investment in their storage, maintenance, and distribution in the form of servers and personnel. The prominent institutes and multinational commissions that are well-funded tend to have the most accessible data. Examples are from IFREMER, NASA and NOAA.

Data centres are very important facilities that are essentially networks of connected servers. Primary objectives are to secure, store and disseminate data. They ensure that the best available scientific data and local knowledge are shared and incorporated in planning and policy development at the national and regional levels. This is particularly important for large datasets. Data centres are also expected to improve accessibility to data, thus allowing the data to be used for scientific research and management of various ecosystems. Examples of data centres are those established under the IOC of UNESCO's Ocean Data and Information Network for Africa (ODINAFRICA) project, the Southern African Data Centre for Oceanography (SADCO), the Partnership for Observation of the Global Oceans (POGO) and the Indian National Centre for Ocean Information Services (INCOS).

National data centres were established under the IOC/UNESCO IODE programme and further developed during the ASCLME Programme. Often there is an investment in these activities during projects, but when the projects are concluded, the servers and portals are no longer maintained. It seems, therefore, a better option is to incorporate data storage on servers and portals that have proven track records when it comes to longevity. An option for re-establishing a

regional data portal that is already viable is the Nairobi Convention Clearinghouse Mechanism (NCCHM) which has recently been redesigned. The NCCHM is a "data reference centre" that provides a portal to data for six emerging trends, including biophysical environment, human environment, economic activities, policy and governance, planning and management and cost-benefits analyses.

There are also meta-databases in place in the region that can document existing data and/or be collected in the future. For example, the Marine Spatial Atlas for the Western Indian Ocean (MASPAWIO 2021provides an open-access geospatial data repository for the WIO. There is also the South African Environmental Observation Network (SAEON 2021). ODINAFRICA had a GeoNetwork metadatabase and produced a data atlas, but the search functions are no longer operational. There are, however, many datasets included in the atlas. The Food and Agriculture Organization of the United Nations (FAO) also has a GeoNetwork metadatabase that provides ocean data. GeoNetwork is freeware and can be used as a standalone installation that can be synchronised with a regional system, avoiding manual uploading processes.

Assessment of access to and sharing of oceanographic data in the WIO region

National datasets are not always readily available online and are generally scattered over more than one national institute. This makes it more challenging for users to access all the relevant data required. Unless specific institutional/project data policies are in place, data are not made easily discoverable. These data may be stored on local servers or desktop computers. This is particularly the case with smaller projects that may have collected valuable data but are not registered on a metadatabase or an archiving portal.

Koranteng and Everett (2019a) provide an inventory of some of the initiatives and institutes that collect oceanographic data and some indication of the accessibility of the data and the hurdles that need to be overcome to gain access. Generally, agreements exist to protect the organisations involved in data and information gathering and sharing and aim to regulate the relationships between the parties (Koranteng and Everett 2019c). These agreements spell out the responsibilities of both parties, particularly concerning the allocation of responsibilities, financial implications and exploitation of products or data required for use/storage. The agreements are intended to avoid potential uncertainties between parties, and they clarify the nature and scope of the relationships. Monitoring of ecosystem processes relies on data availability; therefore, it is necessary to set up agreements with various organisations and institutions in the WIO region to facilitate data availability for this task. The involvement of these entities in long-term monitoring of the LMEs needs to be formalised through specific funding and collaborative agreements. The type of agreement depends on the nature of the entity and the data and information required.

Relevant national institutions identified can be engaged through small-scale funding agreements

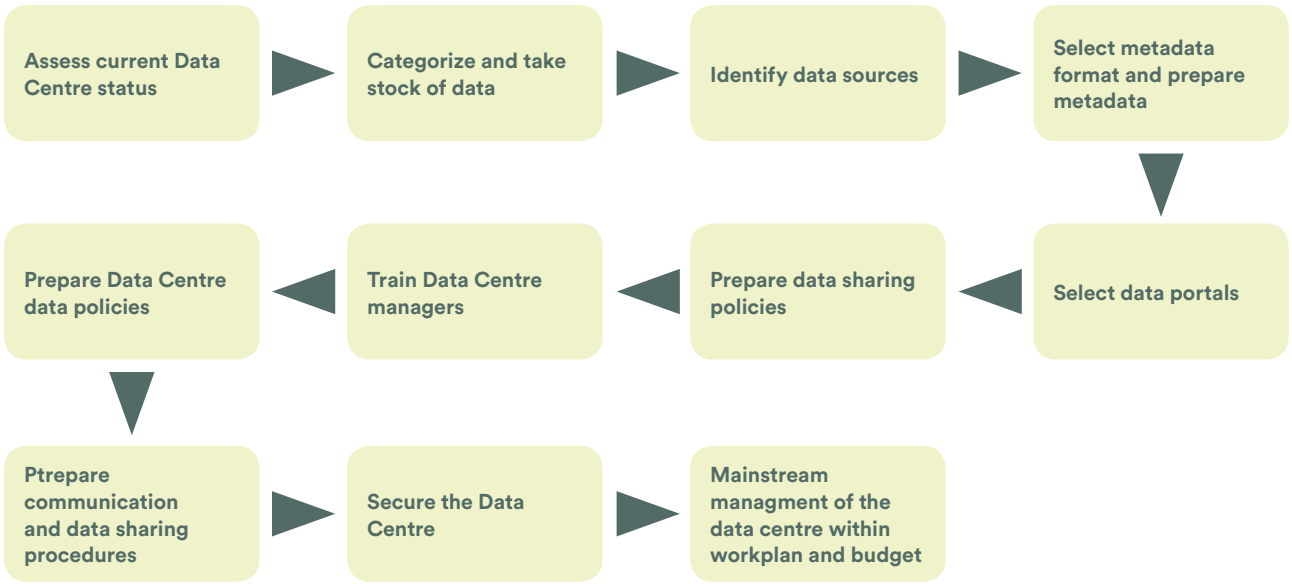

Figure 2: Roadmap to revitalising the national data centres in the Western Indian Ocean (from Koranteng and Everett 2019b)

(SSFA). At the same time, non-profit organisations can enter into collaborative contracts concluded with the Nairobi Convention Secretariat. To secure collaboration with regional bodies that have, among their objectives, long-term conservation and sustainable use of the marine resources, it is necessary to conclude a specific Memorandum of Understanding (MoU) or Letter of Agreement (LOA) where appropriate. Relevant regional technical or subject-matter entities are the Indian Ocean Tuna Commission (IOTC), Southern Indian Ocean Fisheries Agreement (SIOFA), and the South West Indian Ocean Fisheries Commission (SWIOFC).

Reviving the National Oceanographic Data Centres developed during the ASCLME project

The ASCLME-assisted national oceanographic data centres were expected to use internationally accepted standards and best practices for data collection and management. The ASCLME Project offered to support the coordination of effort across the region for the promotion of access to coastal and marine-related information in appropriate forms to underpin informed ecosystem management decisions. At the stocktaking workshop, there were discussions on the state of the data centres established by ASCLME, WIO-LAB and SWIOFP. It became evident that almost all the data centres are still running, although they are in varying advancement and capabilities. Participants noted, however, that the centres are facing several challenges, the most significant being lack of financial resources and adequate human capacity. Generally, operations of the data centres were not mainstreamed in the work plan and budgets of the host institutions and, therefore, not seen as a priority activity that should receive direct funding and staff support.

The participants showed great enthusiasm for the revival of the data centres and noted that this is a vital activity that will benefit the region. It will add substantially to the development of practices that will lead to greater sustainability of ecosystems and their functioning in the region. The meeting noted that provision had been made under the SAPPHIRE programme to help revive the data centres and continue data collection and archiving. This action aims to support the updating of existing national MEDAs, TDA, and National Action Plans (NAP). It was emphasised that it is necessary to re-market the data centres as service providers rather than only data storage units.

In the panel discussions during the stocktaking workshop, the consensus of the panellists was that more emphasis should be placed on providing products that are useful to governance practitioners and processes. By emphasising useable output rather than raw data, the importance of data management and the longevity of data centres will follow. Governments should be seen as the most important clients, followed by regional and global programmes. It was felt that a culture of data sharing among scientists should be encouraged while respecting the ownership rights of the data originators. To this end, it is important to develop data policies to protect the originators and the users.

Koranteng and Everett (2019b) proposed many steps for revitalising the Data Centres (Figure 2), including developing an action plan under SAPPHIRE. The action plan should include the establishment of an ad hoc Working Group on the revitalisation and operation of the data centres. Following proposals were made:

1. Assess the current status of each data centre and the facilities.
2. Categorise data needs and take stock of the required data for each category.
3. Identify sources of data (nationally, regionally, and internationally); historical data should not be forgotten in the enthusiasm of collecting new data and should be revived into useable formats
4. Select a metadata format and prepare metadata of the data and information; re-establish a regional metadata and data portal. The NCCHM comes in handy here.
5. Select data portals; a data portal is "a list of datasets with pointers on accessing data".
6. Prepare data sharing protocols with national, regional and international institutions that hold relevant datasets. The IOC of UNESCO encourages member States to use data centres linked to IODE's National Oceanographic Data Centres (NODCs) and World Data Centre (WDC) networks.
7. Assess and train data centre managers; data management should be the core function of the data managers and not side jobs over and above scientific duties.
8. Prepare a clear Data Policy that defines ownership, access, patent, etc.

Outlook

Several institutes in WIO countries collect good data on essential ocean variables, but many have problems with managing the data. The region's scientists and

policymakers also have access to databases owned by institutions that collect oceanographic data on a global scale and to data from regional research initiatives. However, there appears to be an apparent lack of trust in the data sharing process in the region, but this can be overcome by developing clearly defined policies and protocols for data management and sharing. These policies and procedures should protect the data originators and the data centres from misuse and/abuse of data and provide an element of confidence in the rights and abilities of those involved. Scientists should be encouraged to share their data so that greater benefit will be derived from them than what can be obtained from a single project/product.

Given the UN Decade of Ocean Science for Sustainable Development, revitalising oceanographic data centres in WIO countries is imperative to ensure effective management and sharing of the data we need for the ocean we want.

While infrastructure is a challenge in most countries, improvements can be made to the centres but not necessarily to the same level. Each centre needs to move to a level where it can provide a service to its data user community rather than attain a level beyond its needs and means. Regional standards should be developed for data collection, storage and archiving to enable more fluid data exchange and use. Establishing a regional metadatabase and portal will greatly aid data sharing in the region; the NCCHM can play an important role in providing such service.

It is recommended that the Contracting Parties of the Nairobi Convention requests the Secretariat to support the strengthening of National Data Centres to collect, analyse and share data and information in the region through the following actions:

- Prepare an action plan for the further development and support of National Data Centres as provided under the SAPPHIRE project.
- Support capacity development initiatives aimed at strengthening the capabilities of the National Data Centres and the data centre managers.
- Ensure linkages between National Data Centres and regional mechanisms such as the Nairobi Convention Clearinghouse Mechanism are established to ensure the efficient and effective sharing of and easy access to regionally-relevant information.

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Co-design as the basis for collaboration and science to policy uptake in the Western Indian Ocean Region

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Summary

Nowadays, researchers from different disciplines are expected more and more to collaborate as well as with relevant stakeholders. We must move away from business-as-usual basic research to more applied and transdisciplinary research and the integration of different knowledge. Working across scientific disciplines, regions and societal groups requires new methods and concepts regarding communication, institutional arrangements and funding opportunities. Data provided by international research programs are rarely sufficiently application-oriented or context-specific. Co-design and how to use it is not widely known or intentionally practised in the region yet. However, co-design is an "Iterative and collaborative process involving diverse types of expertise, knowledge and actors to produce context-specific knowledge and pathways towards a sustainable future" (Norström and others, 2020). IOC-UNESCO emphasises the importance of co-design, and co-design was especially highlighted in the context of the Ocean Decade. This paper makes some recommendations to develop a regional vision and guiding principles, build multidisciplinary capacities, and capitalise on the UN Ocean Decade opportunities. These opportunities mainly build knowledge and practice of co-design and embed co-design more broadly across the WIO region. Suggestions for a way forward could be a regional and inter-sectoral Working Group.

Background

Global change and the need for sustainability calls for more integrative research with new strategies and approaches. Research questions need to be defined in interaction with civil society, governments and other stakeholders and should be guided by societal challenges and needs. Researchers from different disciplines are expected to collaborate with relevant stakeholders and focus more directly on producing knowledge to inform society and decision-makers. This means that we must move away from business as usual basic science to more applied and transdisciplinary research and the integration of different knowledge. In this context, Mauser and others argue that integration is an iterative process (Mauser and others, 2013). They propose a framework of co-creation that consists of three stages, throughout which all stakeholders are involved: co-design, co-production and co-dissemination. The term co-design is often used analogously to co-creation and can comprise all three stages.

The UN Decade of Ocean Science for Sustainable Development (Ocean Decade) supports such a transformative process and emphasises the importance of co-design. This is seen as a useful step in illuminating how co-design can shape marine research and policy practice.

The problem

The transition to this relatively new type of research in the marine and policy fields is not without challenges. Working across scientific disciplines, regions, and societal groups requires new methods and concepts regarding communication, institutional arrangements and funding opportunities. Further, co-designing research questions and co-producing knowledge implies all scientists and stakeholders' roles

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and responsibilities. This concerns research projects between the global North and the global South and is also explicitly an issue in integrative and transdisciplinary research projects on the regional and even local level.

However, the problem is illustrated here by the often encountered North-South example. Calls for funding towards collaborative research projects between the global north and global south are usually applied opportunistically due to emerging topics of public interest in the global south (host countries) that increase chances for a successful application. The funding calls themselves often originate from the global north, reflecting the priorities of the global north. Due to legal requirements, project implementation and administration also lie with partners from the global north, further strengthening the imbalance in collaborative research projects and resulting in limited application in the collaborating countries in the global south. In the initial project/proposal conception phase, the process is driven by partners from the global north. The ideas of the "collaborators/partners" are used as sources of inspiration to build on the legitimacy of the process and fulfil the call's requirements.

Moreover, emphasis is put on the submission process, which entails collecting signatures of approval and Memoranda of Understanding (MOUs) from the partners in the global south to justify collaboration and yet offer limited flexibility to these countries to shape the design of the project – presenting "ready-made", predesigned projects to the global south partners. At the end of the project, the original data, in many cases, remain with the collaboration partner from the north with limited access for the partners from the global south for further research or use in science-based decision making. This disparity through all phases of a research project – design, implementation, and generation and translation of results - can lead to frustration and distrust among research partners in the host countries.

Advances – state of the art

In the WIO region, the problems described above are already being addressed by the Nairobi Convention and the Western Indian Ocean Marine Science Association (WIOMSA). Some success with marine research co-design approaches, e.g., as a requirement for collaboration with resource users, has been achieved within The Marine and Coastal Science for Management (MASMA) Programme (WIOMSA 2017). However, co-design and how to use it are not widely known or intentionally practised by many governments, scientists, research organisations, and policy organisations in the region. The current use of co-design in marine research is fragmented but not entirely lacking. But frameworks are missing guiding through co-design processes, and it needs more knowledge of co-design in general practice. Co-design so far is little practised amongst research organisations and even less on the sectoral and policy-making level.

During workshops and interviews conducted in the Western Indian Ocean (WIO) region, interviewees stated that traditional North-South cooperation often neglects the specific needs and expectations of the southern hosts. Other studies (UK Collaborative on Development Sciences 2017; Schmidt and Neuburger 2017) found similar results, highlighting that data provided by international research programs are rarely sufficiently application-oriented or context-specific. The influence of host countries in shaping the focus of international research activities is limited. (World Bank 2016). This erodes trust between partners and can lead to disinterest in further collaborations. Consequently, the projects often don't go beyond the project life but end as soon as the funding comes to a close.

As mentioned before, this disparity is not exclusive to North-South partnerships; regional cross-boundary initiatives, eg research on migratory species or even collaboration among national institutions on the same topic, bear the same risks. Key questions need to be unpacked:

- What are the expectations on critical aspects of the partnership?
- Are the goals consistent on all sides?
- How are the workload and competencies distributed among the partners?
- How is data collected, analysed and shared? It frequently also transcends the project itself.

Co-Design Approaches

Suppose we want to generate innovative science which addresses the current complex human-natural issues. In that case, we will need to integrate the knowledge and traditional wisdom of many diverse stakeholders beyond the scientific community (Wright Morton and others, 2015) and work in a transdisciplinary and inclusive environment. The process of co-designing collaborative inter-and transdisciplinary research projects across complex issues can mitigate many of the

challenges mentioned above. It recognises the importance of non-scientific (e.g. local or traditional) knowledge and the co-production of knowledge by researchers, practitioners, and other stakeholders. The term "co-design" has received considerable attention in several contexts (e.g. knowledge production, product or design development, policy design and dissemination of results) in the past years but is not clearly defined yet (Moser 2016). A recent publication proposes a definition that is based on literature, experiences and perspectives of researchers and practitioners as "Iterative and collaborative process involving diverse types of expertise, knowledge and actors to produce context-specific knowledge and pathways towards a sustainable future." (Norström and others, 2020)

We propose an adaptive framework to jointly develop research projects and policies based on a common agenda and a shared vision. A good example of such an adaptive approach is the four-step approach developed by Future Earth Coasts – Our Coastal Futures, which aims to engage stakeholders for joint problem definition, goal setting and strategy development. A key point of this approach is establishing a reliable partnership among stakeholders, a mandate to act (and an institutional framework for doing so), and a joint definition of targets (Future Earth Coasts 2018). The co-design and co-production will involve scientists, regional decision-makers, the private sector, non-government organisations, and local and indigenous knowledge holders.

Linkage to regional and global processes

Making research relevant for host countries and decision-making processes begins with a joint agenda setting. Projects that base their collaboration on co-design, co-production and co-dissemination are more likely to be context-specific and respond to local (policy) and societal needs. In this way, co-design is an important building block to bridge the science-policy gap and work towards a prosperous and sustainable future. It can support efforts of the Science-Policy Platform of the Nairobi Convention to protect, manage and develop the Western Indian Ocean in partnerships and at the regional level.

As the coordinating body for the upcoming Ocean Decade, IOC-UNESCO has emphasised the importance of co-design. In that regard, IOC organised several regional workshops to prepare the implementation plan to offer opportunities to "co-design mission-oriented research strategies in line with the 2030 Agenda and continental and regional initiatives […]" (IOC UNESCO 2020). Co-design was highlighted in the context of the Ocean Decade by kicking off the Ocean Decade Virtual Series with a session on "Co-designing the science we need for the Ocean Decade". This series emphasised that the Ocean Decade has the

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ambition to trigger a revolution in ocean science by providing a framework for collaborative and participative research and better integrating diverse knowledge systems, disciplines, sectors, and stakeholders.

The "Our Coastal Futures" approach developed by Future Earth Coasts, which aims to provide a forum for regional coastal stakeholders to jointly take transformative actions towards the Sustainable Development Goals, is a regional example of co-design.

Advances – state of art

MeerWissen – African-German Partners for Ocean Knowledge of the German Federal Ministry for Economic Cooperation and Development has integrated a co-design process in its funding program for African-German partnership projects. Proposals for projects to be supported under MeerWissen are developed collaboratively, and a co-design workshop is key to bringing all partners together. For two days, representatives of the African and German institutions involved in the project reflect on their partnership, agree on rules for their collaboration and work jointly on finalising the project concept.

While, for administrative reasons, the funding is channeled only through the German partner, setting up a co-design process helps ensure that the views of all partners are reflected in the project idea. This does not only help build trust among partners and create a basis for a collaboration built on shared responsibility and ownership. It also increases the chances of the research being relevant and useful for all partnering parties and countries. Insights and expertise from the host countries' representatives are essential in designing a project that links well to the political systems, fits the local context and responds to real needs. With this collaborative approach, MeerWissen seeks to set new standards for research collaborations and knowledge transfer in marine sciences.

This co-design approach should evolve beyond the joint design of projects to live a co-design process throughout the project. Such a process needs to include discussion and agreements on data storing and sharing, analysing results and developing capacities, purchasing equipment and questions of ownership, and leading to open dialogue and dissemination of findings among different societal groups. The projects need to also consider the broader picture: Which other stakeholders might be interested in the generated data or results? Are other institutions currently working on a similar topic and might be willing to share resources or expertise? Who else might hold important information or traditional knowledge that might be incorporated into the project? These questions could be addressed by incorporating the "CARE Principles for Indigenous Data Governance", released in 2019 by the Global Indigenous Data Alliance (GIDA). The CARE principles expand on the principles outlined in FAIR (Findable, Accessible, Interoperable, Reusable) data to include Collective benefit, Authority to control, Responsibility, and Ethics, to ensure data guidelines address historical contexts and power differentials (Wikipedia 2020). When designing policies based on project results, it is imperative to incorporate the knowledge and needs of marginalised groups of interest, such as indigenous communities or small businesses.

Recommendations

For the implementation of co-design approaches, an institutionalisation similar to that of participation processes on a regional level may be considered. However, this requires strong political support and the will to eventually anchor such approaches formally if necessary. First and foremost, it remains to be clarified what co-design means in practice and how it benefits political decision-makers, but above all, how the benefits affect the people concerned. If a participatory co-design approach is properly applied:

- Political decision-makers are involved from the very beginning in defining the problem, moving away from purely theoretical research to applied and real-world challenges.
- All relevant actors and their positions are clear from the outset.
- Decision-making strategies can be scientifically substantiated.
- Due to the participatory character, the views of all stakeholders can be directly incorporated
- A common agenda and common vision can be jointly developed from the very beginning reinforcing the potential of a common yet scientific result supporting a quick application, for instance, for political strategies, policy decisions and communications.
- Stakeholders benefit from the transparent decision-making and the opportunity to participate in every step of the research process.

To create the needed political will and support, it is recommended:

- To promote co-designing in ocean science and management as one of the effective ways to

implement the UN Decade Ocean Science for Sustainable Development (2021-2030) in the WIO region.
- To develop a regional vision and guiding principles for co-designing in ocean science and management.
- To initiate short-term and long-term projects/programmes to build multidisciplinary capacities, which are key for continually building and strengthening the co-design approach.
- To capitalise on opportunities provided in the UN Decade Ocean Science for Sustainable Development (2021-2030) and other regional and global initiatives, particularly supporting co-designing approaches.
- To create opportunities for scientists and decision-makers in the marine sector, build knowledge and practice of co-design in a more consistent and coordinated way to support collaboration and science to policy uptake.
- To embed co-design more broadly across the WIO region within marine and coastal research and policy programmes, promoting science-policy uptake.

The second step is to convey a competence base for co-design methods. A knowledge transfer approach with a (digital-) modular system is conceivable, which can be called upon depending on the scientific problem. But to conceptualise and create a competence base in the region, a regional and inter-sectoral Working Group (WG) could be established, which could:
- Design and coordinate the process of phrasing a joint vision.
- Collect and analyse lessons learned and successes in co-design.
- Define criteria for research partnerships in the region (e.g. the Bremen Criteria (ZMT 2015)).
- Test, review, adapt and apply existing guidelines for co-design and promote their implementation.
- Review how research partnerships and co-design approaches in the region can be funded, e.g. through the MASMA programme.
- Create awareness for the relevance of co-design in the research community as well as among decision-makers.
- Support the exchange of experiences as well as the development of capacities of researchers and decision-makers for co-design.
- Proactively approach funding organisations and partners (from the Global North) and encourage funding mechanisms incorporating a co-design and partnership approach.

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