Every account counts for sustainable development: lessons from the African CoP to implement ocean accounts in the Western Indian Ocean region

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Abstract

The Western Indian Ocean (WIO) is critical in supporting the social and economic development of the nations it borders. To safeguard the various opportunities it provides, it is essential to adopt sustainable ocean development models that balance ocean wealth and ocean health. Such models depend on evidence-based and adaptative ocean governance underpinned by holistic social, environmental and economic indicators. The ocean accounts framework provides a standard accounting structure to integrate social, economic and environmental information in alignment with relevant international statistical standards such as the System of National Accounts and the System of Environmental-Economic Accounting. Applying such a framework produces integrated indicators against which changes can be assessed and measured. These indicators also inform decision-making and support the prioritisation of areas requiring further attention by highlighting data deficiencies, ocean governance gaps and under-explored research areas. The framework encompasses and links several systems of accounting that can be used based on specific priorities. However, three initiation points have been identified that can be further expanded and concatenated into other accounts encompassed by the framework. This publication provides practical guidelines to start implementing national, regional or local ocean accounts, following the Global Ocean Accounts Partnership Technical Guidance on Ocean Accounting. It is further complemented by amendments proposed by the African Community of Practice based on lessons learned during the implementation of ocean accounts pilots across the WIO region. Compiling ocean accounts is an adaptative and iterative process and should be constantly ameliorated and adjusted to local contexts and priorities. However, efforts should be made to maintain coherence with the framework and international standards.

Keywords: ocean accounts framework, ocean governance, data integration, statistical standards

Introduction

The ocean supports various human activities, which are rapidly growing due to advances in science and technology (Virdin *et al.*, 2021)while progress toward achieving international goals for ocean conservation and sustainability is lagging. In this context, the private sector is increasingly recognized as having the capacity to hamper efforts to achieve aspirations of sustainable ocean-based development or alternatively to bend current trajectories of ocean use by taking on the mantle of corporate biosphere stewardship. Here, we identify levels of industry concentration to assess where this capacity rests. We show that the 10 largest companies in eight core ocean economy industries generate, on average, 45% of each industry's total revenues. Aggregating across all eight industries, the 100 largest corporations (the "Ocean 100". The expansion of ocean resource-use results in increased pressures

http://dx.doi.org/10.4314/wiojms.si2022.1.11

on coastal and marine ecosystems (Golden *et al*., 2017). To balance the needs and interests of ocean stakeholders (with often competing priorities) with the sustainable use of ocean space and resources, it is critical to balance ocean health, wealth and economic development considerations (Gacutan *et al.*, 2022) economic, and environmental considerations when addressing complex policy challenges and achieving strategic objectives, such as conservation targets, or sustainable and ocean-based economic development agendas. Like many common environmental assets, oceans have been impacted by a history of imperfect governance resulting in substantial negative consequences for these important socio-ecological systems. Aligning and managing multiple trade-offs between policy targets for the management of human activities in the marine domain has been increasingly attempted using Marine Spatial Planning (MSP. The balance between various stakeholders' interests and the definition of ocean sustainable development strategies depends on trade-off analyses that are better achieved when underpinned by evidence-based decision-making (Findlay *et al*., 2020).

The contribution of ocean economies to social and economic development is particularly important for the nations of the Western Indian Ocean (WIO), with its 22.3 million km² of ocean and supporting around 60 million people living in coastal areas (within 100 km of the shore) (Obura *et al.*, 2017). According to the most recent report on the economic contribution of ocean goods and services based on living marine ecosystems (thus excluding activities not dependant on ecological functioning, such as shipping and mining), the total ocean assets were estimated to value at $333.8 billion (Obura *et al.*, 2017).

As a result of such importance and the transboundary nature of resources, numerous regional research collaboration and governance programmes were established to support sustainable ocean management, such as the South West Indian Ocean Fisheries Project (SWIOFP), the UNEP WIO-Lab Project, the Strategic Action Programme for the protection of the Western Indian Ocean from land-based sources and activities (WIO-SAP), the Agulhas and Somali Current Large Marine Ecosystems (ASCLME) project, the South West Indian Ocean Fisheries Governance and Shared Growth Project (SWIOFish) among others (Satia, 2016). Notably, the ocean sustainable development agenda within the WIO region is reflected by the establishment of numerous regional institutions, partnerships, and intergovernmental organisations focusing on supporting multistakeholder engagement (including governments, civil society and academia) and improving ocean governance, such as the Nairobi Convention and its Conference of Parties and Protocols, the South West Indian Ocean Fisheries Commission, the Western Indian Ocean Marine Science Association (WIOMSA), the Western Indian Ocean Governance Exchange Network (WIOGEN) or the Western Indian Ocean Commission / Commission de l'Océan Indien (COI) (Vousden, 2016). Furthermore, most Western Indian Ocean nations are Member States of the Indian Ocean Rim Association (IORA).

Within the 'governance for ocean sustainable development' arena, ocean accounts provide a powerful tool to guide the systematic and consistent compilation of environmental, economic and social information. These are from numerous sources across and between ocean environments and the human use thereof, using international statistical standards (GOAP, 2021a, Gacutan *et al.*, 2022). The power of diverse information is enhanced through integration by using a variety of established accounting systems and satellite accounts relevant to ocean systems (Supplementary Table SM1). Included in these are: the System of National Accounts (SNA) (United Nations, 2008) and aligned Ocean Economy Satellite Accounts (OESA) (Colgan, 2016); the System of Environmental-Economic Accounts – Central Framework (SEEA – CF) (United Nations *et al.*, 2014); andw the System of Environmental-Economic Accounts – Ecosystem Accounts (SEEA – EA) (UNSD, 2021). These and other accounting systems currently being tested and adapted (e.g., Social Accounts, Governance Accounts, and Pressure and Risk Accounts) can be integrated into an Ocean Accounts Framework (OAF) by compiling groups of tables of stocks and flows (Fig. 1, Supplementary Table SM2). For example, the flows of goods and services from ecosystems to economic sector supply and use, and the resulting benefits to social systems link ecosystem accounts, ocean economy accounts and social accounts in one direction. Conversely, the pressures of economic resource-use activities on ecosystems and the resultant natural state change and impacts link social, economic and ecosystem accounts in the opposite direction.

The information compiled through the groups of tables on a regular basis and the systematic linkage between stocks and flows from various accounting systems result in robust knowledge products. These

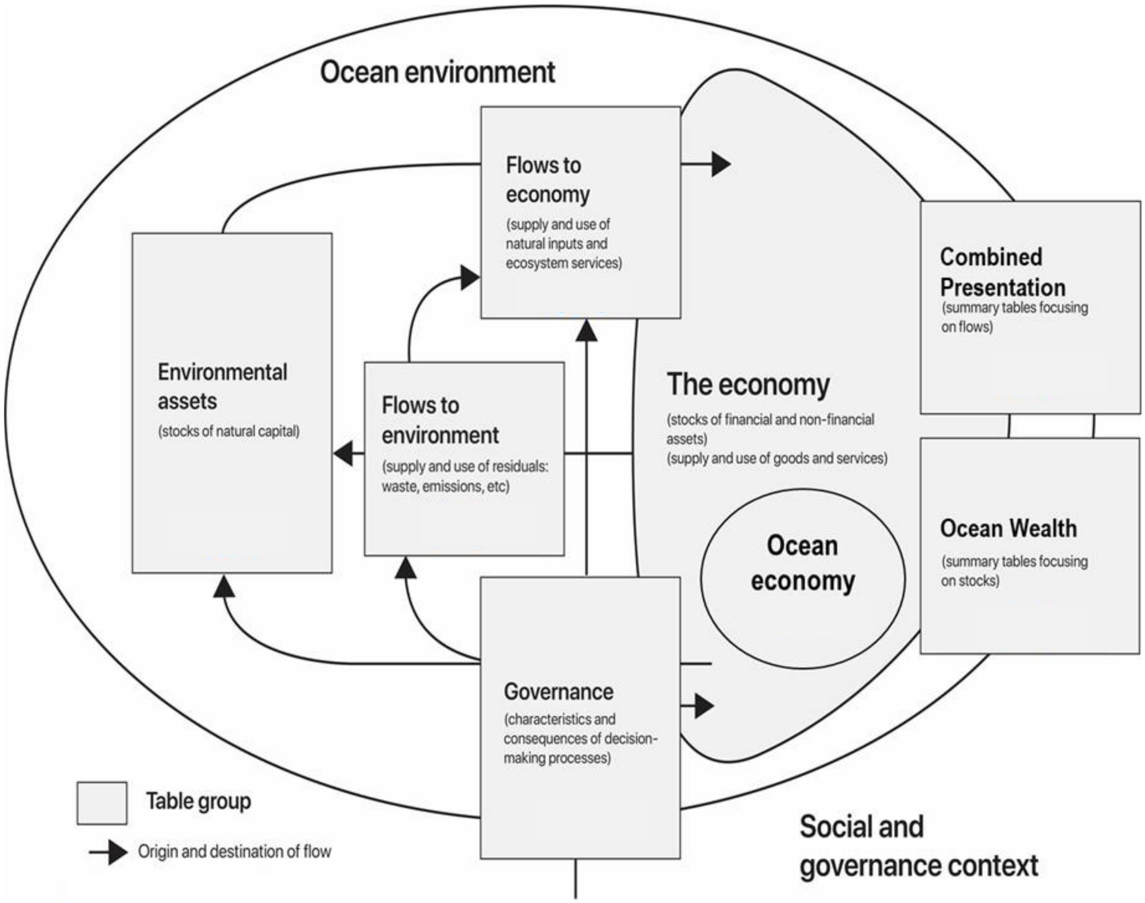

Figure 1. General structure (groups of stocks and flows, as tables) of the Ocean Accounts Framework adapted from the Technical Guidance on Ocean Accounting (GOAP 2021a).

include statistics and indicators for monitoring and reporting ocean resource uses (including benefits and costs), the equitable and inclusive share of the benefits of such use, ocean wealth and ocean health (Fenichel et al., 2020). As a result, ocean accounting data provides a foundation to support development planning, including the definition of goals and strategies for ocean sustainable development within expanding ocean economies. Ocean accounting data also underpin informed decision-making processes, including ocean governance and adaptive policy development cycles across social, economic and environmental domains, the management of the ocean space, the definition and monitoring of protected areas, and the designation and allocation of investments by sector, social groups or locations. It can also facilitate ocean monitoring and assessment, highlighting gaps in knowledge of statistics, governance and research, identifying areas requiring prioritisation; and finally, it enables the incorporation of data-heavy information systems arising from technological advances in ocean sciences.

Such a holistic approach is critical as nations recognise the need to move beyond economic data alone to drive informed decision-making and governance processes (Stiglitz *et al.*, 2018). Be that as it may, establishing ocean accounts can be intimidating in their scope. As an integrated framework, it requires a range of data, information and knowledge from a variety of stakeholders and agencies. The critical role of multidisciplinary teams and the need for collaborative stakeholders' engagement outside their areas of expertise could result in hesitation or resistance to engaging with ocean accounts. Notably, since the OAF is fundamentally an assemblage of accounts as modules, it is often not necessary or possible for the entire process to be resolved from the outset. Selected accounts can be compiled based on specific policy questions, governance needs, national priorities, data availability, and technical capacity. While the concurrent full compilation of ocean accounts is not required, it is critical to ensure the employment of a common framework so that individual systems and flows within the OAF can be integrated later.

Accordingly, all assembled data must be organised in specific and standard structures that enable: a) spatial and temporal comparisons; b) spatial or temporal disaggregation for informed management processes, including the development of indicators; and c) ensuring that accounts can be expanded to integrate other accounting systems over time.

Although accounts within the OAF can be selected depending on the questions and targets to be addressed, there are clear initiation points of the accounting processes that align with the accepted or established accounting systems. For example, policy demand could prompt the compilation of marine ecosystem accounts from an environmental perspective, natural capital accounts from a resource-use and supply perspective, or ocean economy satellite accounts from an economic perspective. Additionally, the novel ocean accounts areas extending existing international standards (i.e., social, pressure, risk, impact, or governance accounts) still depend on compiling at least one established accounting system.

This paper presents a concise stepwise approach to start the development of ocean accounts. It draws on the Global Ocean Accounts Partnership Technical Guidance for Ocean Accounts (GOAP, 2021a) and is complemented by adaptations to the guidance proposed and validated by the African Community of Practice (ACoP), resulting from practical experience through the implementation of ocean accounts across the WIO region. To fully understand how to develop and use ocean accounts, it is recommended that the GOAP Technical Guidance for Ocean Accounts is consulted, which details how to apply the statistical framework, integrate information, and use the results to address policy priorities.

Key initial steps

Certain initial and iterative steps (Fig. 2) are required before implementing ocean accounts and initiating the compilation of information. *Step I is the engagement with stakeholders* to define and identify the focus and scope of the accounting process (similar to the development of most ocean governance tools). The formulation and/or the identification of policy priorities and/or governance gaps to be addressed and the selection of the accounting area (as defined by policy needs or existing jurisdictional boundaries) is a priority. Additionally, depending on the scope, this step may require identifying ecosystems, ecosystem services and natural capital assets; determining resource uses, economic sectors and activities, supply and use of natural, built, and human capital;

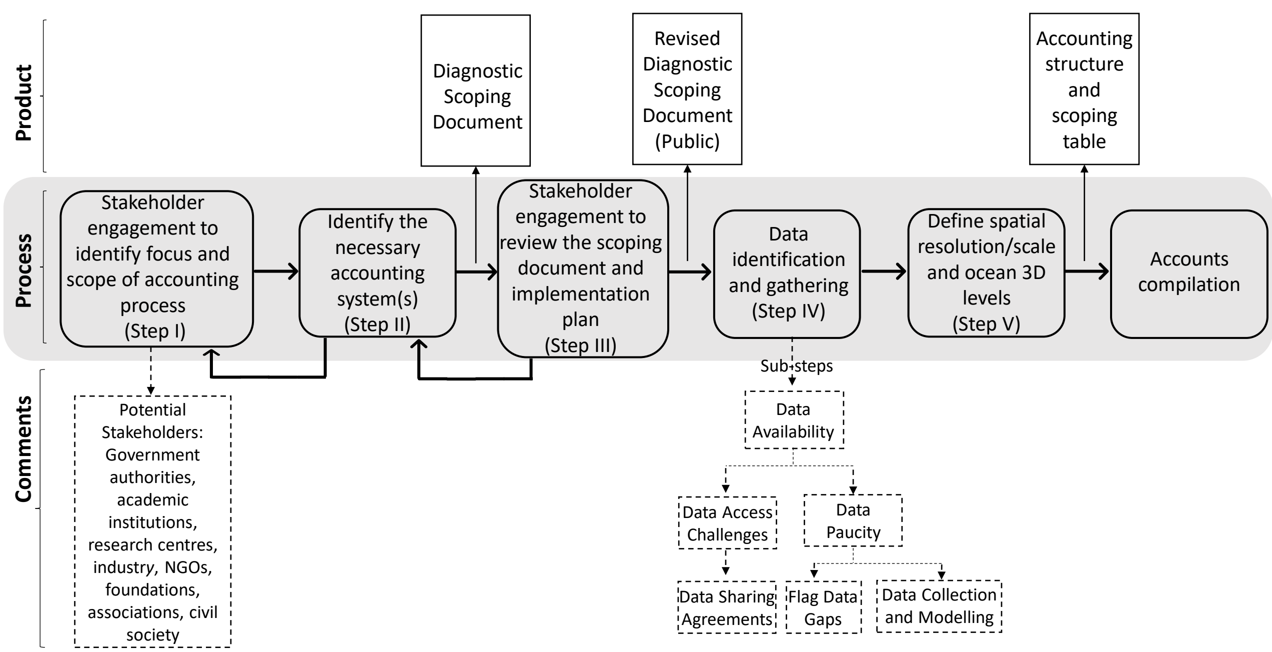

Figure 2. Initial and iterative steps before compiling the information for incorporation into selected ocean accounts. The blocks in the grey area evidence each step of the initial process (before the implementation of ocean accounts *per se*). Product blocks represent the outputs of specific steps. Comments and sub-steps are identified below in the dashed blocks.

and identifying and quantifying pressures, risks and impacts of resource use activities.

In Step II, the accounting systems (within the OAF) that require consideration to address the focus and scope (defined in step I above) in an integrated manner is identified. This includes the scoping and scaling of the process and selection of the top-down (economic demand use-driven) *vs* bottom-up (environment supply-driven) approaches.

Steps I and II conclude in a diagnostic scoping document that outlines the road map for the ocean accounting process outlined by the Ocean Accounts Diagnostic Tool (Supplementary Table SM3). This diagnostic tool guides a structured dialogue among data users, data producers and data holders to advance the strategic implementation of ocean accounts (GOAP, 2021b). Of particular importance is the recognition that the value of ocean accounting is critically boosted by the continuity and repeatability of accounting periods, resulting in ongoing indicators.

In Step III, there is another process for engaging with stakeholders to identify the components, subcomponents, assets, ecosystem services, and flows of ocean economy resource-uses and activities and facilitate two-way information flows of input data gathering and output product sharing. This engagement should provide stakeholders with a 'voice' to instil public and citizen confidence in the process while opening space for a bottom-up perspective that includes indigenous knowledge and values (Gacutan *et al.*, 2022).

Step III results in a Public Scoping Document (identified as the revised scoping document) that reviews and adapts the diagnostic scoping document (from steps I and II) to ensure that all the necessary activities and resources-uses are included.

Step IV is a comprehensive data identification and collection exercise, including identifying data availability, scarcity, and access challenges to address the relevant scope of the accounting process. Where data paucity is identified, data gaps must be flagged, and data collection and modelling can fill critical gaps. For example, physical and biogeochemical features (e.g., waves and currents, vertical convection, temperature, depth, species abundance) can be obtained through remotely sensed data or numerical modelling and can be further used to define ecosystem typology or condition, quantify assets, evaluate pressures, etc. (Moore *et al.*, 2019; Chai *et al.*, 2020). However, it is also important to recognise that developing such models can be challenging due to the dynamic and irregular quality of ocean characteristics and because model construction, reliability and validation are also data-dependent (Fujii *et al.*, 2019). The feasibility of data collection must also be assessed and the methodology defined. Where data access is an obstacle, data sharing agreements (including consideration of proprietary data) may be used to overcome such challenges. Integral within this step is identifying the available data architecture and software to accommodate big ocean data and liaising with global ocean accounting practitioners to draw on their data management experiences to ensure data architectural availability and compatibility.

Finally, in Step V, the spatial resolution and scale of available data required for accounting are defined. This includes the three-dimensional approaches to ocean resolution, e.g., surface, water column, and seafloor, or epipelagic, mesopelagic, bathypelagic, abyssal-pelagic, and hadopelagic, among other appropriate level definitions. Of particular importance is the establishment of relevant basic spatial units[1] (BSUs) at the appropriate spatial scale, bearing in mind that coarser resolution through aggregation has advantages over disaggregation.

Steps IV and V should result in a clear scoping table that identifies the diagnostic scoping process and the public process (Supplementary Table SM4). These final steps should also result in defining the accounting structure and identifying the systems and flows that will be incorporated into the process. It is important to bear in mind that the defined accounting systems used within the framework may need to be expanded, and other accounting systems might need to be integrated with time. In addition, it is critical to prioritise appropriate metadata approaches and strategies to ensure confidence in data used during steps IV and V.

Potential entry points for developing ocean accounts

Each of the accounts encompassed by the OAF can be compiled individually or as part of a set of selected accounts, depending on the particular policy questions or governance needs to be addressed. This allows for the definition of specific indicators that are relevant to different processes and goals. The integration between accounting systems depends

[1] the smallest spatial element underlying the accounting process.

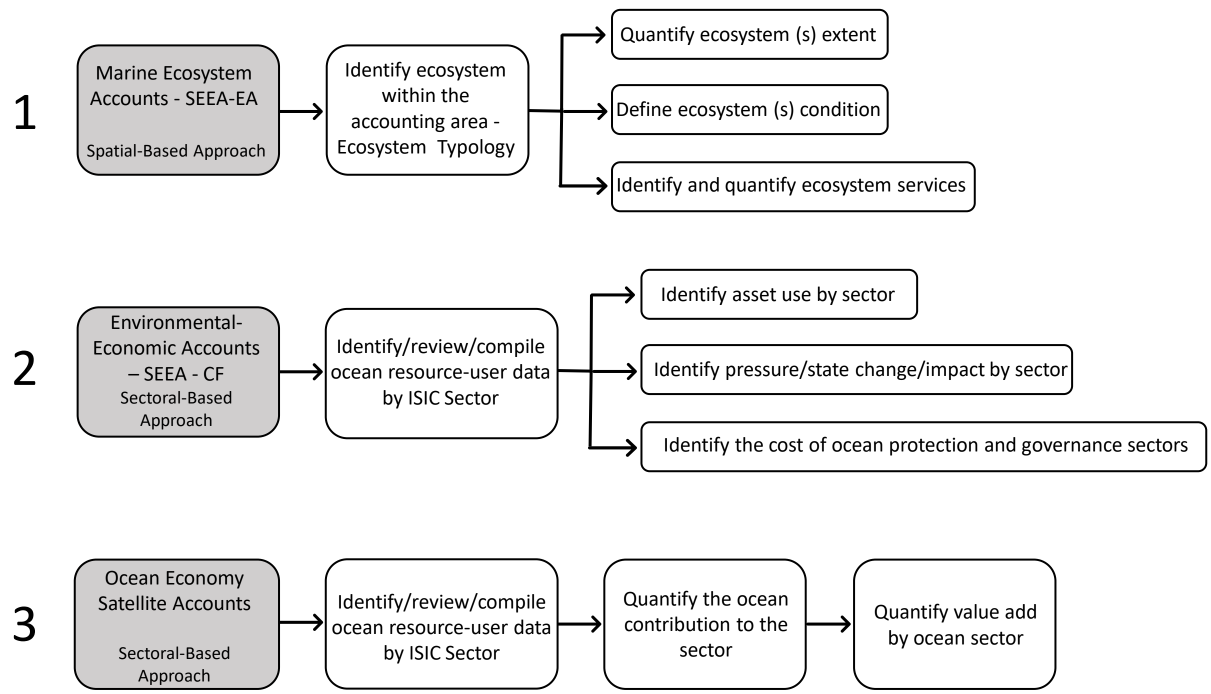

Figure 3. The three possible entry points (grey boxes) to compile ocean data through the ocean accounts framework for the WIO region. System of Environmental-Economic Accounts – Ecosystem Accounts (SEEA – EA); Environmental-Economic Accounts – Central Framework (SEEA – CF); International Standard Industrial Classification of All Economic Activities (ISIC).

on identifying flows between the different accounting systems being compiled, enabling the conversion of information, such as from physical natural capital supply flows to monetary economic supply flows. Accordingly, different accounting systems can be used as starting points for developing an ocean accounts, and the steps to be followed depend on the accounts to be compiled (Fig. 3).

It is recommended that one of the already established statistical standards encompassed by the OAF is utilised as a starting point, as those have specific and well-defined guidelines: Marine Ecosystem Accounts, Environmental-Economic Accounts, or Ocean Economy Satellite Accounts.

Marine Ecosystem Accounts

This starting point can be prioritised when the governance gaps or policy questions to be addressed are related to natural capital and profit being carried out at a spatial scale. It enables identifying and quantifying the stocks of natural resources and the flows of goods and services from ecosystems to society. Following the OAF guidelines, these flows can be further linked to economic, social, governance and risk components. The approach described in this section (Fig. 4) is an ocean-focussed adaptation of the SEEA - EA guidelines (UNSD, 2021), and further details can be found in the original document and at the GOAP Technical Guidance on Ocean Accounting (GOAP, 2021a). The SEEA - EA, as a subset of environmental-economic accounting, follows international standards to monitor the ecosystem's extent and condition and their supply of ecosystem services to sectors of the economy, government and households.

The steps for the Marine Ecosystems Account are presented below:

a. Define the ecosystem accounting area for which the information will be compiled.

b. Identify the ecosystem types occurring in the accounting area within each BSUs. Ideally, qualifying ecosystem typologies require empirical biophysical data that consider the highly dynamic nature of ocean processes, the porosity of ocean boundaries and the three-dimensional nature of the ocean space. Accordingly, ecosystem typology can use two complementary approaches: oceanographic biophysical and geochemical characteristics (empirical or modelled) or Earth Observation (EO) approaches by analysing satellite imagery and related ground-truthing. Although using EO

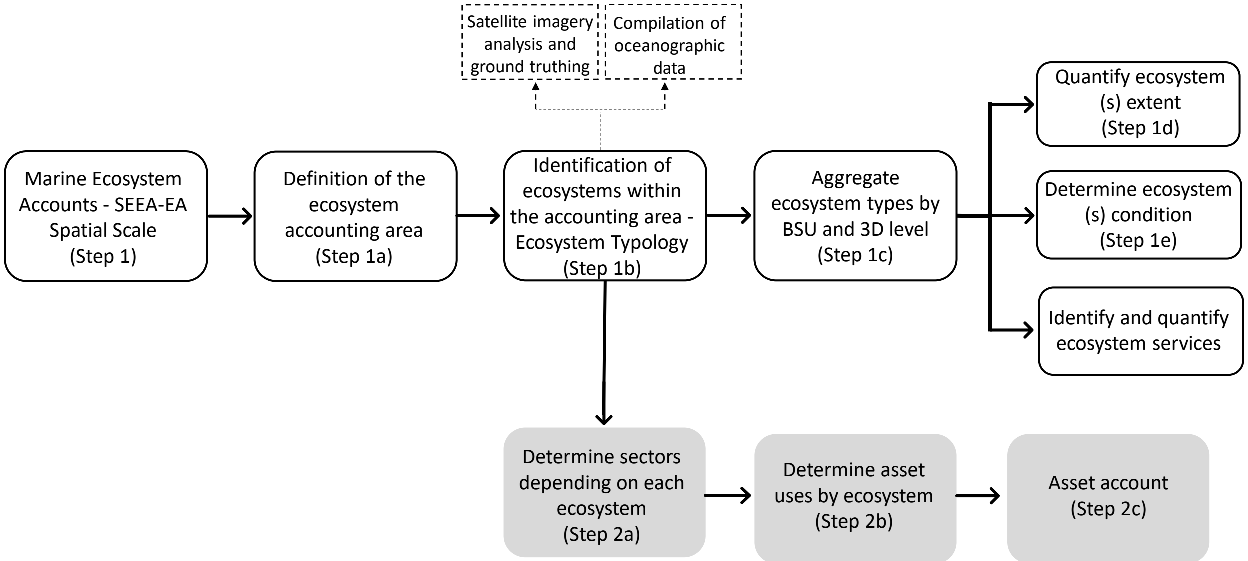

Figure 4. Stepwise approach for the development of Marine Ecosystem Accounts. Each step is defined by a block (solid line). The dashed blocks represent potential ways of classifying ecosystem types. Grey blocks represent steps linked to the System of Environmental-Economic Accounts – Central Framework (SEEA - CF) component of Environmental accounts. System of Environmental-Economic Accounts – Ecosystem Accounts (SEEA – EA); Basic Spatial Unit (BSU).

approaches requires skilled professionals that may not be available, partnering with regional and international organisations and prioritising capacity building in this area can help overcome this challenge. Moreover, whilst ground truthing can be expensive, the costs and time investment associated to *in loco* ecosystem mapping would be much higher. The IUCN Global Ecosystem Typology (Keith *et al*., 2020) allows for consistency across accounting processes in different accounts compilation. It is also important to consider consistency in typology with the SEEA – CF, Land Accounts, and the SEEA – EA ecosystem extents for terrestrial and freshwater ecosystems. When using oceanographic data, it is necessary to compile and interrogate biophysical ocean variable data (either empirical and/or modelled) (see, for example, the Global Ocean Observing System (GOOS) Essential Ocean Variable (EOV) categories provide a comprehensive array of the types of data that may be incorporated) to assess data availability at observed and modelled scales (Supplementary Table SM5, column 1 for each BSU). These variables should be compiled within a consistent time frame (e.g., quarterly, as in Supplementary Table SM5 (line 8) for variables expected to have temporal variation (e.g., temperature)) and for each of the BSU 3D levels considered in the study. The 3D levels should be defined at a relevant scale, with as many levels as required to address the accounting scope (e.g., Surface, Epipelagic, Mesopelagic, Bathypelagic, Seafloor).

c. Aggregate the ecosystem typology information by 3D level and BSU (Supplementary Table SM6). The ecosystem types identified may be composed of discrete and isolated patches. Depending on the focus and scope of the accounting process, such patches may be aggregated in different management units of the same ecosystem type, thus having their information compiled individually.

d. Quantify and evaluate the extent (as a measure of stock) of each ecosystem type identified (and ecosystem type unit when relevant) by 3D level and BSU (Supplementary Table SM7). Ecosystem extent is commonly measured in terms of area (e.g., km^2, ha), but other measurement units can be defined (e.g., volume). After that, the extent of each ecosystem is consolidated through the aggregation by type (and type unit where necessary) for the accounting period (Supplementary Table SM8), with the opening account arising from the closing account of the previous period.

e. Evaluate the opening and closing condition (as a relative measure of change) of each ecosystem type (and type unit) for the opening and closing accounting period (Supplementary Table SM9). The condition can be qualified using various parameters that can be defined according to the information available and the characteristics of each specific ecosystem type. Examples include developing indicators based on biotic and abiotic attributes through various frameworks (Smit *et al.*, 2021).

The SEEA – EA includes ecosystem services accounts in which each ecosystem's physical and monetary supply of ecosystem services in the accounting area are identified and quantified. This step is not described here, but further information can be obtained from the SEEA – EA guidelines (UNSD, 2021).

Environmental-Economic Accounts (aligned to the SEEA – CF)

The compilation of environmental-economic accounts aligned to the SEEA – CF enables the quantification of monetary and physical aspects of natural or non-produced material supply (e.g., wild fish) to the economy (La Notte and Rhodes, 2020). Commencing through this component should be prioritised when identifying and quantifying the use or depletion of natural resources (renewable or non-renewable) and the costs of management activities by economic sectors. This approach focuses primarily on discrete environmental assets and their relationship to the economy (as opposed to the focus on ecosystem assets through the SEEA - EA), identifying and quantifying: 1. stocks and flows of ocean assets (e.g., fish); 2. the positive input flows of residuals from economic sectors to the environment, allowing the identification of pressures resulting from such flows and the linkage among these pressures to ecosystem condition and extent changes (as part of the Ecosystem Accounts- Step 1); and 3. the expenditure of countries on ocean protection and governance as Environmental Activity Accounts. Notably, as this approach also identifies pressures and their connection to governance tools, it evaluates policy efficacy, contributing to adaptative policy cycles. Accordingly, when starting the compilation by environmental-economic accounting, it is possible to link the natural capital asset used by economic or other human activity, to the ecosystems and spatial units related to the provisioning of each asset, thus connecting this step to step 1 above (Fig. 5).

The steps for the Environmental-Economic Account are presented below:

a. Identify spatially determined sectors of the ocean economy by the International Standard Industrial Classification of All Economic Activities (ISIC) code (UNSD, 2008) using or potentially using resources from each ecosystem type (and type unit) by BSU and 3D Level (Supplementary Table SM10). Furthermore, non-market sectors and non-use values should be included, even if their value is qualitative instead of quantitative (e.g., bequest value of heritage sites or dugong populations).

b. Determine the environmental assets provided to each resource-use sector by ecosystem type responsible for supporting them (Supplementary Table SM11). Non-market assets (i.e., consumed by people but not traded in markets) such as wildlife viewing, snorkelling, or surfing can also be identified and related to the ecosystem type, BSU and BSU level supporting them.

c. Account for the environmental assets by quantifying opening stock, alterations and closing stocks as a percentage in each ecosystem related to the asset's maintenance and/or production (Supplementary Table SM12). For example, the ecosystem contributions to a fish stock may hypothetically extend across estuarine (nursery habitat), pelagic water column (feeding habitat) or subtidal reef (breeding habitat).

d. Identify the environmental assets used ("economically produced") by each economic sector and specific industry, quantify their stocks (e.g., a fish stock assessment), the resource use allocation (e.g., a fish stock total allowable catch (TAC)) and supply (e.g., catch) to the economic sectors and industry evaluated (Supplementary Table SM13). Note that this will result in a table for each asset contributing to a specific sector and/or industry.

e. Identify the produced and human capital, intermediate consumption, and natural capital utilised by economic sectors and subsectors. Such capital utilisation indicates "effort" utilised in resource supply (Supplementary Table SM14). The costs of resource-use components and the asset use of 2b (physical and monetarised values) may be incorporated to identify contributions to resource rents.

f. Accounting for economic sector risks to the environment can be performed by identifying and determining residuals and / or pressures arising from each resource use sector specified in step 2a (linked to Supplementary Table SM10). This

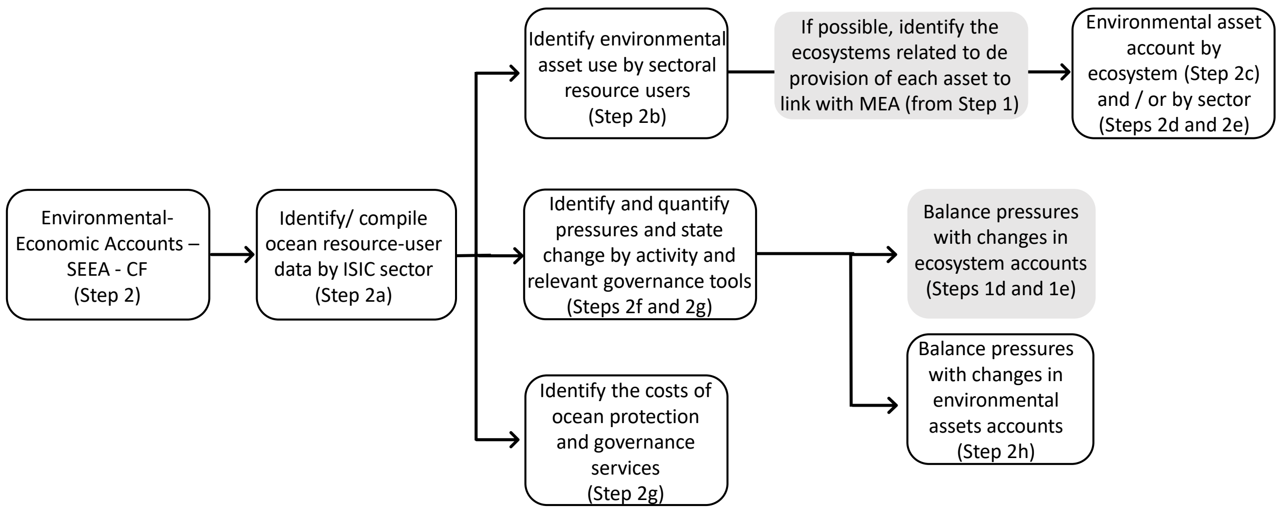

Figure 5. Stepwise approach for developing Environmental Economic Accounts aligned to the System of Environmental-Economic Accounting – Central Framework (SEEA – CF). Each step is defined by a block (solid line). Grey blocks represent a possible way of expanding this component, linking them to other systems of the Ocean Accounts Framework, e.g., Marine Ecosystem Accounts (MEA).

step can be expanded using the Driver-Pressure-State-Impact-Response (DPSIR) conceptual framework or another framework from its family, such as the DAPSI(W)R(M), which includes **D**rivers of basic human needs that require **A**ctivities that lead to **P**ressures and consequently to **S**tate change on the natural system, thus leading to **I**mpacts (on human **W**elfare), requiring **R**esponses (as **M**easures) (Elliott *et al.*, 2017) physicochemical processes and socio-economic systems. An increase in competing marine uses and users requires a holistic approach to marine management which considers the environmental, economic and societal impacts of all activities. If managed sustainably, the marine environment will deliver a range of ecosystem services which lead to benefits for society. In order to understand the complexity of the system, the DPSIR (Driver-Pressure-State-Impact-Response. These frameworks are used to identify the relationships between human activities and ecosystems (i.e. social-ecological systems), link the causes and effects of processes and their management, as well as the resulting (or potential) outcome of policies (Elliott and O'Higgins, 2020). In this guide, following the DAPSI(W)R(M) model, it is considered that ocean resource use activities (i.e., sectors and industries) lead to pressures on marine and coastal ecosystems (e.g., pollution, overfishing, introduction of exotic species). Such pressures are the agents of state change to natural systems that result in impacts on social systems. Accordingly, the following broad categories of state change and impact are identified: 1. Loss of Ecosystem Structure, Function or Productivity (EP); 2. Biodiversity Loss (B), or 3. Provisional, Regulatory or Cultural Ecosystem Service Loss (ES) (Supplementary Table SM15). Notably, information on such state changes and impacts depends on recurrent environmental monitoring or assessment as part of the accounting process. When linking this component of the SEEA-CF to the SEEA-EA through the OAF, it becomes possible to identify and measure the flows from the economic pressures (as pressure flows) to the environment and specific ecosystems and assets by identifying the activities that affect ecosystem extent (Supplementary Table SM8) or condition (Supplementary Table SM9), as well as associated asset stocks. Pressures (including residuals) and impacts may be linked to governance tools and support the assessment of their efficacy in pressure, status change and impact mitigation, and social accounts by identifying the implications of such pressures and state change on human welfare (qualitatively and / or quantitatively).

g. Quantify (if possible) pressures identified in step 2f.

h. Balance (if possible) pressure identified in step 2f with changes in ecosystem condition or extent (steps 1d and 1e) and environmental assets accounts (step 2b).

Environmental activity accounts under the SEEA-CF can be used to measure the costs, benefits and efficacy of environmental management and protection by identifying the "spend" on environmental management practices and requirements to address anthropogenic pressures / state changes identified in step 2f and, or any natural disaster change – such changes may be intertwined where there are anthropogenic drivers of natural change. Such "spend" may include, for example, the non-commercial maritime services of education, training and research technology and innovation, ocean governance activities, defence and maritime security, marine protection services, maritime information and communication service, safety at sea and environmental remediation services.

Ocean Economy Satellite Accounts (OESA)

The OESA uses the same principles and structures of the SNA but provides a discrete group of exclusive ocean-related sector accounts (Colgan, 2016). As such, this component is a good starting point when requiring economic metrics to quantify the contribution of ocean sectors to the economy to support decisions about investment, spending, and macroeconomic management. This component of the OAF provides macroeconomic indicators that are essential to measure and track the economic component related to the ocean's economic contribution to the industry sectors. Accordingly, the relevant steps of the Ocean Economy Satellite Accounts are as below (Fig. 6):

a. Identify sectoral-determined market resource supplies to economic sectors arising from consumptive and non-consumptive use of living and non-living resources as ISIC-defined sectors (UNSD, 2008) and Central Product Classification products (UNSD, 2015).

b. Balance sectors and products of step 5a with steps 2a and 2b.

c. Develop an ocean economy Supply and Use table (SUT) for ocean industry sectors/products (Supplementary Table SM16) from existing monetary SUTs of the System of National Accounts (SNA) to determine sectoral gross value add (GVA) and gross output of ocean sectors over the accounting period (Supplementary Table SM16).

d. Develop appropriate Input-Output tables (IOTs) for the ocean industry sectors / products from the SUTs of step 5c (Supplementary Table SM17). This step will require the development of a production matrix and use tables for imports and domestic outputs and their transformation to IOTs based on technology or sales structure assumptions. The selection of the type of IOTs (product by product versus Industry by Industry) depends on the objective of economic analysis.

e. Develop computable general equilibria (CGE) models for analyses dependent on ocean decision support requirements (for example, the development of scenario planning for Marine Spatial Planning needs). This optional step enables the advancement of a descriptive assessment to an analytical approach.

f. Align SUTs and IOTs with physical supply identified within the SEEA – CF accounts (Step 2b) to develop Physical Supply and Use tables (PSUTs) (Supplementary Table SM18) and other potentially relevant tables

After starting the compilation of information through the OAF by any of the three entry points mentioned above, it is possible to expand to other accounts of the OAF according to the specific needs and priorities motivating the accounting exercise. It is possible to add different information and improve the reliability

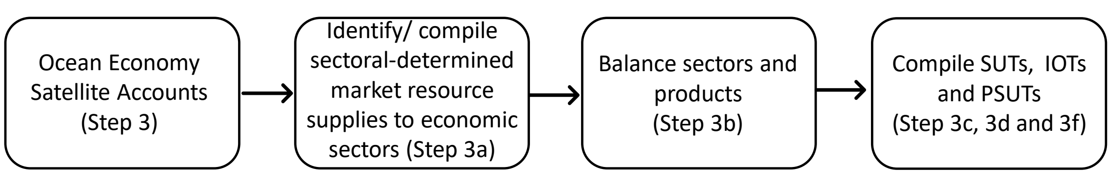

Figure 6. Stepwise approach for developing Ocean Economy Satellite Accounts. Supply and Use table (SUTs); Input-Output tables (IOTs); and Physical Supply and Use table (PSUTs).

of the statistics and indicators generated over time. The critical aspect is to ensure that the data is entered coherently to keep the links between the systems and enable spatial and temporal comparisons.

Conclusions

The importance of the ocean to humans is undeniable. Accordingly, it is crucial to shift many processes towards sustainable and inclusive strategies for the ocean's economic development, thus maintaining coastal and marine ecosystems' structure and functioning, ocean health, and pursuing the equitable provision of ecosystem services from which humans benefit. That is highlighted within the WIO region by the various blue economy programmes and initiatives under implementation, for instance, the Go Blue[2] partnership in Kenya, the ProAzul[3] in Mozambique, the Mauritius Blue Economy Initiative, the Seychelles National Blue Economy Strategic Framework and Roadmap[4], the three IORA Blue Economy declarations[5], and others (Elza, 2016, Doyle, 2018, Overbeeke *et al*., 2022).

Within such a "Blue Economy" transformation, where local, national, regional, global and even international organisations aim at prioritising ocean sustainable development, it is necessary to weigh and manage various (often conflicting) interests (Bennett, 2018). This complex task requires evidence-based and adaptative ocean governance underpinned by multidisciplinary indicators (Brodie Rudolph *et al*., 2020, Voyer *et al*., 2021) such as those provided by ocean accounting. Implementing ocean accounts is critical to supporting long-term and well-distributed use of ocean opportunities through a consistent, standardised, holistic framework that integrates environmental, social, and economic data. As such, the OAF supports a process for monitoring drivers of change (including climate change and ocean resource use) and how they affect the environment, economy and society. This includes their current effects and impacts, the extended (or prolonged) consequences, and how decisions now affect future opportunities. The OAF also underpins tracking and reporting on the progress toward achieving the SDGs. Such a framework for accounting also supports strategic and planning decisions and the choice of appropriate investments for sustainability. Finally, an OAF supports regulatory decision-making, including the grant of concessions, permits and licenses for ocean-related activities; and the evaluation of cost-benefit trade-offs. Accordingly, implementing OA enables the long-term monitoring of ocean health and wealth.

Bearing in mind the emerging use of ocean accounts in the WIO region, this stepwise guide facilitates the implementation of national ocean accounts. It identifies potential entry points for the implementation of ocean accounting and explains how to compile and integrate marine ecosystem accounts, natural capital accounts and OESA. Novel systems are being piloted, and the processes for their implementation will be described in future publications. Additionally, due to the modular nature of the OAF, countries that already have accounting programmes in place can use them as a starting point to further advance ocean accounting. Examples in the WIO region include the development of Natural Capital Accounting in Madagascar and South Africa (Driver *et al*., 2015, Onofri *et al*., 2017), the evaluation of the ocean economy in Mauritius (Scandizzo *et al*., 2018), and blue carbon accounts in Tanzania and Mozambique (Gullström *et al*., 2021). The selection of the entry point will, of course, depend on aspects such as the policy questions or governance gaps to be addressed (following a demand-driven workflow), local capacity, data and infrastructure available (data-driven workflow), stakeholder engagement and input (particularly on the initial iterative steps (Fig. 2)), programmes already in place, etc. (GOAP, 2021a).

The implementation of ocean accounts presents challenges such as those related to data (availability, accessibility, sensitivity, sharing and acquisition – particularly from often silo'ed data holders), stakeholder engagement and the lack of human capacity and appropriate experience across all environmental, economic and social domains (Halderen *et al*., 2020). To identify solutions to arising issues, overcome challenges and improve the framework, the GOAP supports the development of several ocean accounts pilot studies around the globe and promotes collaboration, information exchange, and partnership. Through these pilots, some enabling factors for successful implementation were identified and included the careful execution of the initial iterative steps in collaboration with various stakeholders, the production of a comprehensive scoping report, and the prioritisation of an initially small focal area to be further scaled up.

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[2] https://www.goblue.co.ke/

[3] https://www.proazul.gov.mz/

[4] https://seymsp.com/resources/blue-economy-roadmap/

[5] https://www.iora.int/en/priorities-focus-areas/blue-economy

Acknowledgements

This work was supported by the Cape Peninsula University of Technology, the South African Research Chairs Initiative through the South African National Department of Science and Innovation/National Research Foundation, the Community of Practice grant in Ocean Accounts Framework (UID: 125455), and by the UK Government's Blue Planet Fund investment into the Global Ocean Accounts Partnership (GOAP), administered by the Department for Environment, Food and Rural Affairs (DEFRA) (ECM_61617). The opinions expressed in this publication are not necessarily those of the funding bodies. The input and discussions with Global Ocean Accounts Partnership Members are acknowledged in the formulation of concepts and methods introduced in this paper.

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Supplementary Material

Table SM1. Established accounting systems and satellite accounts relevant to ocean systems. Source: OECD Glossary of Statistical Terms (https://stats.oecd.org/glossary/index.htm). *Not defined within the OECD Glossary for Statistical Terms; definition based on Jolliffe *et al.* (2021) and Chang *et al.* (2021).

Term	Acronym	Definition
System of National Accounts	SNA	The internationally agreed standard set of recommendations on compiling measures of economic activity. The SNA describes a coherent, consistent, and integrated set of macroeconomic accounts in the context of a set of internationally agreed concepts, definitions, classifications, and accounting rules.
System of Environmental-Economic Accounting	SEEA	The System for integrated Environmental and Economic Accounting is a satellite system of the SNA that comprises four categories of accounts. The first considers purely physical data relating to flows of materials and energy and marshals them as far as possible according to the accounting structure of the SNA. The accounts in this category also show how flow data in physical and monetary terms can be combined to produce so-called "hybrid" flow accounts. Emissions accounts for greenhouse gases are an example of the type included in this category. The second category of accounts takes those elements of the existing SNA which are relevant to the good management of the environment and shows how the environment-related transactions can be made more explicit. An account of expenditures made by businesses, governments, and households to protect the environment is an example of the accounts included in this category. The third category of accounts in the SEEA comprises accounts for environmental assets measured in physical and monetary terms. Timber stock accounts showing opening and closing timber balances and the related changes over the course of an accounting period are an example. The final category of SEEA accounts considers how the existing SNA might be adjusted to account for the impact of the economy on the environment. Three sorts of adjustments are considered: those relating to depletion, those concerning so-called defensive expenditures and those relating to degradation.
Satellite Account	-	Satellite accounts provide a framework linked to the central accounts and enable attention to be focussed on a certain field or aspect of economic and social life in the context of national accounts; common examples are satellite accounts for the environment, tourism, or unpaid household work.
Ocean Economy Satellite Account*	OESA	A satellite account that measures all economic activity directly dependent on oceans, including activities that use ocean resources as an input (e.g., fishing), produce products and services for use in the ocean environment (e.g., shipbuilding) and depend on the ocean due to geographic proximity (e.g., coastal tourism, warehouses that service ports).
Tourism Satellite Account	TSA	Provides a basic system of concepts, classifications, definitions, tables, and aggregates linked to the standard tables of the 1993 System of National Accounts from a functional perspective. This system has been developed to measure tourism's economic impacts on a national economy on an annual basis.

Table SM2. Summary of the groups of stock and flow tables used by the Ocean Accounts Framework (OAF). Source: GOAP (2021).

Table Group	Summary
Environmental asset* (natural capital)	Records the physical status and condition, and monetary value of environmental assets (natural capital), including minerals and energy, land and soil, coastal timber, aquatic resources, other biological resources, water, and ecosystems, including biodiversity. *For the OAF, the environmental assets are focused on marine and coastal (ocean) assets.
Flows to economy (supply and use of ocean services, including goods)	Records inputs from marine and coastal environmental assets to the economy, including ocean-related materials (abiotic and biotic), energy, water, and ecosystem services. These inputs can be recorded in terms of physical quantities and monetary value.
Flows to environment (residuals including ecosystem impacts)	Records, in physical units, the outputs from the economy to the ocean environment, including solid waste, air emissions, water emissions, and impacts on ecosystems.
Ocean economy (as a contribution to the broad economy)	Records the monetary value of production, consumption, accumulation, imports, and exports in economic sectors deemed relevant to the ocean and non-market services in comparison to the broad economy (e.g., national economy). The economy is reflected in the Ocean Accounts as users of ocean services and suppliers of residuals (pollutants) and activities that affect the ocean.
Governance	Records a range of information (physical status, monetary value, and/or qualitative status) concerning collective decision-making about oceans, and the wider social and governance context in which such decisions are made. The information recorded in governance tables includes the status and/or value of protection and management of ocean environment, the "environmental" goods and services sector of the ocean economy; relevant taxes and subsidies; applicable laws and regulations; health, poverty and social inclusion; risk and resilience; and ocean-related technologies. Inclusion of health, poverty, and risk management may require a separately identified social account to address inclusivity within the overall account framework.
Combined presentation	Records a "report card" of summary information (physical quantities, monetary value, and/or qualitative status) and indicators concerning the flows of benefits and costs (the latter broadly defined as maintenance and restorations costs, disservices and externalities) between the ocean environment and the economy. This information includes but is not limited to: the share of Gross Value Added / Gross Domestic Product attributable to the ocean economy; ocean resource rents; depletion, degradation and adjusted net savings relevant to oceans; contributions of oceans to human well-being (employment, sense of place) that are not recorded in the SNA; and relevant information concerning health, poverty and social inclusion.
Ocean wealth	Records summary information (in terms of physical quantities and/or monetary value) concerning a country's (or other region's) stock of ocean wealth, including relevant stocks of environmental assets recorded on a SEEA balance sheet; economic/financial assets recorded on an SNA balance sheet; a subset of environmental assets that are defined as "critical" according to agreed criteria; the resource life of environmental assets; and relevant societal assets such as education and health systems.

Table SM3. Ocean Accounts Diagnostic Tool (Version 3, June 4, 2021). Source: https://www.oceanaccounts.org/ocean-accounts-diagnostic-tool/

Diagnostic Component	Practical Actions
Statement of Strategy and Policy Priorities	Document national visions and priorities related to the ocean, the environment, biodiversity, sustainable development, and green/blue economy, including managing natural assets and flows of services from them. Link priorities to environmental concerns, such as pollution or overfishing.
Institutions	Identify stakeholders, including producers and users of related information (government agencies, academia, NGOs, international agencies), but also other groups such as civil society that can benefit from improved information. Identify relevant institutional mechanisms currently in place. Review the role of the National Statistical Office to highlight the advantages of integrating information and approaches across the National Statistical System.
Knowledge	Identify key national data sources that can be used as a basis for further development.
Progress	Understand what progress has already been made in developing ocean data, statistics and accounts, and other environment statistics and accounts.
Context	Identify related statistical development activities that could benefit (and benefit from) ocean accounts initiatives.
Priorities	Determine the priorities for action to develop selected ocean accounts.
Constraints and opportunities	Assess (a) constraints to implementing specific ocean accounts and (b) opportunities for immediate actions to address these constraints.

Table SM4. Example of a scoping table containing the general information about the accounting process. The reference to annexures in column two exemplifies the need to link this scoping table to other relevant detailed documentation. 'Accounting period' refers to the start (open) and end (closing) dates of the accounting process, while 'temporal resolution' refers to the frequency in which accounts will be performed (periodicity). 'BSU', in the section' spatial information' means 'basic spatial unit', and the spatial 3D Levels or Zones selected are examples as different depth levels may be chosen. Cells in grey are null (empty) by definition.

Accounts Information	
Account Name:	
Type of Account(s):	
Compiled by:	
Compiled for:	
Addressed Imperatives:	
Data Providers	
Datasets	
Stakeholders	
Area Description	
Northern Boundary:	
Western Boundary:	
Eastern Boundary :	
Southern Boundary:	
Coastal Buffer Inclusion:	
Accounting Period	
Open Date:	
Close Date:	
Temporal Resolution within accounting period (y/n):	
Spatial Information:	
Finest BSU Spatial Resolution:	
GIS Spatial Software Environment:	
Projection:	
Number of Spatial 3D levels:	
Spatial 3D Levels	**Depth**
Sea Surface	
Epipelagic	
Mesopelagic	
Bathypelagic	
Seafloor	
Sub-seafloor	

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Table SM5. Raw data table of ocean biophysical variables applied for each basic spatial unit (BSU). The variables and their categories, the spatial 3D levels or zones, and the temporal interval selected are examples and may vary depending on the project scope.

BSU Number

BSU-All Levels

Biophysical Province:

Depth:

Substrate Type:

BSU Individual Levels

3D Level		Surface				EpiPelagic				MesoPelagic				Bathypelagic				SeaFloor				Sub-Seafloor			
Time frame		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Physical Variables	Ocean surface heat flux																								
	Ocean surface stress																								
	Sea ice																								
	Sea state																								
	3D Level height																								
	Salinity																								
	Temperature																								
	Currents																								
Biogeochemical Variables	Dissolved organic carbon																								
	Inorganic carbon																								
	Nitrous oxide																								
	Nutrients																								
	Oxygen																								
	Particulate matter																								
	Stable carbon isotopes																								
	Transient tracers																								
Biological Variables	Fish abundance and distribution																								
	Coral cover and composition																								
	Invertebrate abundance and distribution																								
	Macroalgal cover and composition																								
	Mangrove cover and composition																								
	Macrofauna abundance and distribution																								
	Microbe biomass and diversity																								
	Phytoplankton biomass and diversity																								
	Seagrass cover and composition																								
	Zooplankton biomass and diversity																								
Other	Ocean colour																								
	Ocean Sound																								

Table SM6. Ecosystem typology characterised at each basic Spatial Unit (BSU) and respective 3D level. Ecosystems separated in various disconnected patches were identified as individual units (u).

3D level BSU	Sea Surface	Epipelagic	Mesopelagic	Bathypelagic	Seafloor
1	Type 1 (u1)	Type 1 (u1)	Type 1 (u1)	Type 1 (u1)	Type 1 (u1)
2	Type 3	Type 3	Type 2	Type 2	Type 2
3	Type 4	Type 4	Type 4	Type 4	Type 4
4	Type 1 (u2)	Type 3	Type 3	Type 3	Type 3
5	Type 1(u2)	Type 1(u2)	Type 1(u2)	Type 1(u2)	Type 1(u2)
6	Type 1(u2)	Type 1(u2)	Type 1(u2)	Type 1(u2)	Type 1(u2)
7	Type 3	Type 3	Type 2	Type 2	Type 2
8	Type 4	Type 4	Type 4	Type 4	Type 4
9	Type 2	Type 4	Type 4	Type 4	Type 4
10	Type 2	Type 4	Type 4	Type 4	Type 4
11	Type 2	Type 4	Type 4	Type 4	Type 4
12	Type 1(u2)	Type 1(u2)	Type 1(u2)	Type 1(u2)	Type 1(u2)
13	Type 3	Type 3	Type 2	Type 2	Type 2
14	Type 3	Type 3	Type 2	Type 2	Type 2
15	Type 4	Type 4	Type 4	Type 4	Type 4
16	Type 3	Type 2	Type 2	Type 2	Type 2
17	Type 4	Type 4	Type 4	Type 4	Type 4
18	Type 4	Type 4	Type 4	Type 4	Type 4
19	Type 2	Type 4	Type 4	Type 4	Type 4
20	Type 1(u3)	Type 1(u3)	Type 1(u3)	Type 1(u3)	Type 1(u3)

Table SM7. Ecosystem extent accounts of each ecosystem type identified at the accounting area by 3D level and basic spatial units (BSUs). Ecosystems separated in various disconnected patches were identified as individual units (u).

3D level (e.g., Sea Surface)			
Ecosystem Type	**BSU**	**Extent (km²)**	**Total Extent**
Type 1 (u1)	1		
Type 1 (u2)	4		
	5		
	6		
	12		
Type 1 (u3)	20		
Type 2	9		
	10		
	11		
	19		
Type 3	2		
	7		
	13		
	14		
	16		
Type 4	3		
	8		
	15		
	17		
	18		

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Table SM8. Ecosystem extent accounts for each ecosystem type's opening and closing stocks identified in the accounting area. Ecosystems separated in various disconnected patches were identified as individual units (u). Examples of factors affecting additions and reductions to opening and closing extent stocks are provided.

	Ecosystem Types					
	Type 1 (u1)	Type 1 (u2)	Type 1 (u3)	Type 2	Type 3	Type 4
Opening stock						
Managed expansion						
Natural expansion						
Reclassifications						
Discoveries						
Reappraisals (+)						
TOTAL addition						
Managed regression						
Natural regression						
Reclassifications						
Extractions/harvesting						
Reappraisals (-)						
State change regression						
TOTAL reduction						
Closing stock						

Table SM9. Ecosystem condition accounts for each ecosystem type's opening and closing stocks identified in the accounting area. Ecosystems separated in various disconnected patches were identified as individual units (u). The opening and closing conditions of each specific indicator can also be determined.

	Ecosystem Types					
	Type 1 (u1)	Type 1 (u2)	Type 1 (u3)	Type 2	Type 3	Type 4
Opening condition						
Indicator 1						
Indicator 2						
Indicator 3						
Closing Condition						
Indicator 1						
Indicator 2						
Indicator 3						

Table SM10. The ocean market, non-market and resource use, and non-use value contributions of each ecosystem type are identified at the accounting area by basic spatial unit (BSU) and 3D level

BSU	BSU Level	Ecosystem Type		Market Uses				Non-Market and Non-Use Values		
			Sector	e.g., Fishing/ Aquaculture		e.g., Offshore oil and gas				
			Description	Marine Fishing	Marine Aquaculture	Extraction of crude petroleum	Extraction of natural gas	Direct Use	Indirect Use	Non-Use Value
			ISIC Code	0311	0321	0610	0620	e.g., Non-Market Recreation or cultural ecosystem services	e.g., Regulatory Ecosystem Services	Existence or Bequest Values
			Ocean share of the sector	Full	Full	Partial	Partial			
1	1									
1	2									
1	3									
1	4									
1	n									
2	1									
2	2									
2	3									
2	4									
2	n									
3	1									
3	2									
3	3									
3	4									
3	n									

Table SM11. Assets provided by each marine ecosystem type to advance ocean sector by BSU and 3D level.

			Sector	e.g., Marine fishing			
BSU	3D Level	Ecosystem Type	Industry	e.g., Trawl		e.g., Pelagic Purse Seine	
			Asset	Hakes	Kingklip	Sardine	Anchovy
1	1						
1	2						
1	3						
1	4						
1	n						
2	1						
2	2						
2	3						
2	4						
2	n						
3	1						
3	2						
3	3						
3	4						
3	n						

Table SM12. Environmental asset account with the opening and closing stocks at each ecosystem type that contributes to asset's maintenance and/or production. Ecosystems separated in various disconnected patches were identified as individual units (u). Examples of factors affecting additions and reductions to opening and closing stocks are provided.

		Ecosystem Type (may extend across ecosystem levels)					
		Type 1 (u1)	Type 1 (u2)	Type 1 (u3)	Type 2	Type 3	Type 4
Asset 1	**Opening stock**						
	Managed expansion						
	Natural expansion						
	Reclassifications						
	Discoveries						
	Reappraisals (+)						
	TOTAL addition						
	Managed regression						
	Natural regression						
	Reclassifications						
	Extractions/harvesting						
	Reappraisals (-)						
	State change regression						
	TOTAL reduction						
	Closing stock						

Table SM13. The extent and supply of natural capital assets to the economic sector. This table links the ecosystem supply of identified natural capital to economic supply or use by industry sectors in a natural capital accounting process. Cells that are grey shouldn't be filled.

Sector: e.g., Marine fishing Industry Asset: e.g., Wild fish	Stock / Asset extent	Resource Use Allocation	Resource Use = Economic Supply	Totals
Opening stock				
Managed expansion				
Natural expansion				
Reclassifications				
Discoveries				
Reappraisal Additions				
Total addition				
Managed regression				
Natural regression				
State change regression				
Reclassifications				
Reappraisals Reduction				
Extractions / harvesting				
Total reduction				
Closing stock				

Table SM14. Account structure for produced and human capital and intermediate consumption and natural capital assets utilised by economic sectors and industry. The balance of this account could identify the resource rent for the particular asset.

Sector: e.g., Marine Fishing Industry Asset: e.g., Wild fish	Human Capital	Built Capital	Intermediate Consumption	Resource Supply	Totals
Human Capital					
Opening Stock					
Additions					
Reductions					
Closing Stock					
Built Capital					
Opening Stock					
Investment					
Depreciation					
Closing Stock					
Intermediate Consumption					
Item 1					
Item 2					
Item 3					
Permitting and Licencing					
Fees					
Natural Capital					
Opening Stock					
Additions					
Resource Use					
Other Reductions					
Closing Stock					
Resource Rent					

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Table SM15. Pressures and the resultant state change and impact from ocean resource use activities, the ecosystem indicators related to such factors and the identification of relevant governance tools. Illegal, unreported and unregulated fishing (IUU)

Activity	**e.g., Marine Fishing**	**State Change/ Impact Categories**		**State Change/Impact Indicators**			
Pressure		Ecosystem Structure, Function or Productivity Loss (EP); Biodiversity Loss (B), and/ or Provisional, Regulatory or Cultural Ecosystem Service Loss (ES).	Mitigation/ Management Plan and/or Governance Mechanisms in place (Yes/No) and identify Extent Change (Positive / Negative / Null)	Ecosystem	e.g., Type 1 (ul)	Ecosystem	Type 2
				Condition Change (Positive / Negative / Null)	Extent Change (Positive / Negative / Null)	Condition Change (Positive / Negative / Null)	
Chronic Production Pressures/Impacts							
1	**Extraction**						
1a.	Physical extraction						
1a1.	Freshwater extraction						
1b.	Biological extraction						
1b1.	Bycatch or Incidental						
1b2.	IUU						
2	**Pollution**						
2a.	CO^2 emission						
2b.	Chemical						
2c.	Acoustic						
2d.	Physical						
2e.	Light						
3	**Habitat Loss**						
3a.	Physical Habitat Loss						
4	Invasive Species						
4a.	Transport/Introduction						
4b.	Facilitation/Spread						
Acute Production Pressures							
5	**Pollution Events**						
5a.	Oil spill						
5b.	Hazardous Casualty						
5c.	Contaminants Runoff						
6	Habitat Loss Events						
Chronic Consumption Pressures							
7	CO^2 emission						
8	Waste Production						

Table SM16. Ocean Economy Supply and Use table (SUT) for ocean industry sectors and products. Cells that are grey shouldn't be filled.

Supply					
	Domestic Industry Production	Import			Total
	Industry Sector (e.g., by ISIC)				
Product Types (e.g., by CPC)	Output by Product and by Industry	Imports by Product			Total Supply by Product
Total	Total Output by Industry	Total Imports			Total Supply
Use					
	Intermediate Use by Industry Sector	Final use by category			Total
	Industry Sector (e.g., by ISIC)	Final Consumption	Gross Capital Formation	Export	
Product Types (e.g., by CPC)	Intermediate Consumption by Product and Industry	Final Uses by Product and by Category			Total Use by Product
Value Add	Wages				Value Add
	Taxes on Production				
	Operating Surplus				
	Total Value Add				
Total	Total Output by Industry	Total Final Use by Category			

Table SM17. Product by product Input-Output table (IOT). Cells that are grey shouldn't be filled.

	Homogenous units of production			**Final Use Categories**			**Total Use**
	Sector 1 Products	**Sector 2 Products**	**Sector 3 Products**	**Final Consumption**	**Gross Capital Formation**	**Exports**	
Sector 1 Products	Intermediate Consumption by Product and by Homogeneous Units of Production			Final Uses by Product and by Category			Total Use by Product
Sector 2 Products							
Sector 3 Products							
Value Added	Value Added by Components						
Imports for Similar Products	Total Imports by Product						
Supply	Total Supply by Homogeneous Units of Production			Total Final Use by Category			

Table SM18. Example of a Physical Supply and Use Table (PSUT). Cells that are grey shouldn't be filled.

Supply							
		Industries Industry Sectors (e.g., by ISIC)	Imports	Final Consumption	Gross Capital Formation	Environment	Total
Products	Product types (e.g., by CPC)	Output produced by Industry	Imports by Product				Total Supply by Product
Natural Resource Uses	Consumptive Use of Living Resources					Flows from the Environment	Total supply of Natural Capital
	Non-consumptive Use of Living Resources						
	Use of Non-Living Resources						
	Ocean Space						
Pressure / Residual	Unsustainable Extraction	Pressures / Residuals generated by Industry		Pressures / Residuals generated by Final Consumption	Pressures / Residuals generated by Capital Formulation / Decommission	Flows to the Environment	Total "supply" of Pressures / Residuals
	Pollution						
	Invasive Translocations						
	Habitat Degradation						
	Climate Change						
Use							
		Industries Industry Sectors (e.g., by ISIC)	Exports	Final Consumption	Gross Capital Formation	Environment	Total
Products	Product types (e.g., by the Central Product Classification (CPC) Version 2.1)	Intermediate Consummation of Products by Industry	Final uses by Product and Category				Total Use by Product
Natural Resource Uses	Consumptive Use of Living Resources	Natural Capital Resource Use					Total Natural Capital Use
	Non-consumptive Use of Living Resources						
	Use of Non-Living Resources						
	Ocean Space						
Pressures / Residuals	Unsustainable Extraction	Mitigation of Pressures / Residuals generated by Industry			Accumulation of wastes / effluent		
	Pollution						
	Invasive Translocations						
	Habitat Degradation						
	Climate Change						

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