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A Plot for Sustainability – The Sustainable Development Goals as A Narrative

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Abstract: The Sustainable Development Goals, while complex at first sight, express a simple narrative about the relationships between people and nature. This paper illustrates this in the context of a coral reef land or seascape supporting coastal people. Coral reefs, their health described by measures of coral and fish diversity and abundance, provide key services and benefits to people. These services directly support 10s of millions of jobs in multiple economic sectors in coastal and distant states, protect and harbor communities and cities across tropical coastlines, sustain use of living and non-living resources, provide transport infrastructure and valuable natural products, and in future may provide energy solutions. Through these multiple benefits, coral reefs contribute to reducing hunger and poverty, thus improving health, and potentially strengthening gender and social equality. However, access and use result in pressures that may drive decline in coral reef health. Broader land and seascape factors also affect reef health, including land-use change and altered freshwater flows, as well as climate change. Managing this complex system requires appropriate awareness and knowledge, governance mechanisms and investments by stakeholders. This narrative can be used from local to global levels, motivating actions and policy at and across these scales to sustain ecosystem function and use, for the oceans what is also increasingly called a blue economy.

Keywords: Sustainable Development Goals; sustainability; ecosystem-based approach; blue economy; coral reef; coastal systems; landscape; seascape

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Introduction

In recent years, 'blue economy' and sustainable development concepts have become core elements in national and international discussions and planning for development. The Sustainable Development Goals (SDGs) (fig. 1) identify priority goals selected by countries in the United Nations General Assembly in ratifying Agenda 2030, 'the future we want', in September 2017 [1]. Due in 2030, they express global aspirations for a prosperous, equitable and sustainable future, based on an inclusive, 'soft', goal-setting, non-binding model [2]. To make them more tangible, they have been elaborated into 169 targets, each of which may be assessed through 1 or more indicators [3]. This complexity is daunting, particularly as success means achieving them all as an indivisible whole, not focusing exclusively on just one or a select few. Thus, since their ratification in 2017, countries and sub-national stakeholders and entities have been struggling to work out how to implement them successfully, and measure progress credibly [4].

The term 'blue economy' is analogous to the concepts of 'green economy' and 'sustainable development', focused on economic value generated from ocean (and freshwater) systems. Principles for a blue economy are widely accepted [5,6,7], though precise definitions of the blue economy have been very varied [6,8]. The term 'ocean economy' is sometimes used synonymously, though this may often not include aspects of sustainability, with a focus on maritime transport, energy and other sectors that don't have a dependence on ecosystems and their productivity. Importantly, as for sustainable development, blue economy addresses the triple-bottom-line of achieving economic, social and environmental benefits simultaneously. In this sense, blue economy may be viewed as "the SDGs from an ocean perspective" and could be expressed as "rather than a focus on SDG14 (the ocean) itself, what do the other 16 goals look like through the lens of the ocean?".

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Figure 1. The 17 Sustainable Development Goals.

Reconciling the holistic nature of the SDGs within the confines of the current economic paradigm focused on Gross Domestic Product [9], based on monetary valuation and growth, is challenging, though valuation is a critical tool for assessing balance and interactions among multiple sectors. Monetary valuation focuses on tangible goods and/or human-derived services, and deals poorly with nature and complex social interactions. Blue economy and sustainable development concepts internalize limits to growth, where mainstream economic thinking seeks to maximize growth in value (wealth). The disconnect between the mainstream economic model and natures limits are plain to see in coral reefs, in their widespread degradation near large and growing population centers [10], rapidly depleting coral reef fisheries worldwide[11], expanding dead zones and sedimentation from rivers and runoff that kill reefs [12], and climate warming that has induced 3 global bleaching events and mass coral mortalities between 1998 and 2017 [13]. All of these multiple and interacting threats, from local to global scales, driven by population and economic growth combined, have resulted in the loss of 50% of coral reefs worldwide [14] and future projections of ocean warming all but assure reefs decline to < 1% of their original range unless massive transformations in global governance for sustainability are implemented [15].

This fate is not unique to coral reefs, and other natural systems are projected to collapse with further climate change [15,16]. There is growing consensus, expressed from local to global levels, that economic growth must be brought within the biophysical constraints of nature – for example in relation to pollution, exceedance of planetary boundaries, climate change, and other indicators of extreme and potentially irreversible impacts to nature [9,16]. But the comprehensive nature of the SDGs [2]. and the limitations of economic models to value nature-based and intangible benefits [17] impede progress.

Coral reefs are useful model for this analysis as they are a flagship ecosystem, recognized both for their great tangible and intangible values to people [18,19], as well as for their beauty, both resulting from their incomparable biodiversity and productivity. A microcosm of ocean systems and vulnerability, coral reefs illustrate the fate of other ecosystems in the ocean, as well as those on land. Their role as a canary for not just climate change, but human-nature interactions is at the forefront of international discourse, being highlighted in all major global assessments in recent years including the 5th Assessment Report of 2014 [20], '1.5 C report' [15] and oceans and cryosphere [21] reports of the Intergovernmental Panel on Climate Change (IPCC), and the global assessment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) [14]

Method

This paper transposes the aspirations expressed by the SDGs onto a model of ecosystem service provision and societal values (Fig. 2a). It expresses our knowledge about ecological function, how this affects service provision and benefits received by people (both monetary and non-monetary), how these affect broader aspects of societal welfare, and the effects of people and service-use on nature and its ability to provide the services. I use coral reefs as the model system, and how they are embedded in a

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populated land- or seascape, whether rural or urban, developing or developed. The model is based on explicit and tangible interactions (e.g. extraction of fish) that can be measured to assess the sustainability of human-nature interactions, balance and reconcile monetary and other metrics that address the core dynamics of the system, and provide explicit guidance for decision-making. The model is applied at the level of a coral reef land- or sea-scape, addressing where the ecosystem and its broader spatial and temporal dimensions produce services used by people through varied economic sectors. The interactions and links in this model are well-supported by the literature through varied ecosystem [22,23] and human dimensions models [24]. The IPBES conceptual framework [25,26] provides a foundation for this model, focused on the flows between nature and people, mediated through 'contributions from nature to people'.

The model also builds on recent work focused on interactions, at the level of goals and targets [27,28,29]. But borrowing from the blue economy approach [6], rather than focusing on interactions with goal 14 and its targets, this model "looks through goal 14 as a window to the other 16 goals". This enables the holistic and indivisible nature of the SDGs to explicitly frame the resulting narrative, providing the big picture or birds eye view. Twinning this with the ecosystem-use model (Fig. 2a) forges a mechanistic focus that goes a level deeper than the goals and targets to specific variables and indicators, enabling quantification of these relationships.

Results

The model takes the form of a set of assertions (Box 1, Fig. 2b), in 150 words establishing the relationships among all 17 SDGs for an exploited coral reef. Looking through goal 14 towards the other 16 goals, the model provides a narrative, or storyline, for expressing the interactions and balance between nature and people. The narrative is simple and compelling, addressing the problem statement and gap identified for this paper, which is in resolving the complexity of the SDG model for practical application and measurement at multiple scales.

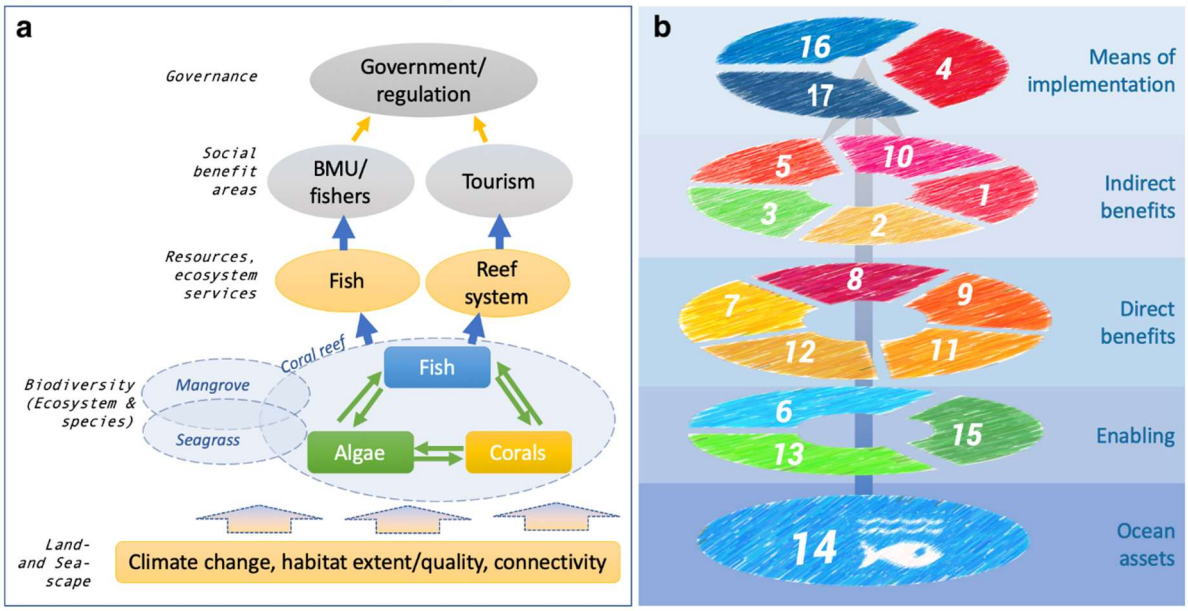

Figure 2. a) Functional model of coral reef and societal interactions, extending from the spatial and temporal aspects of the seascape at bottom, through species and their ecological interactions (i.e. biodiversity) to resource and ecosystem provision to multiple economic and societal sectors, with overarching governance regimes reflecting values and principles held by the societal actors. b) Schematic model of the 'coral reef-SDG model', showing the approximate correspondence with the functional model in (a), starting at the base with the coral reef as a natural asset, and moving upwards through the stages in the narrative model in Box 1, grouped as enabling factors, direct benefits, indirect benefits, and finally the means of implementation for the SDGs.

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From this simple narrative the model can be built up with greater rigour around each goal (model component) and its interactions with others (Fig. 2b, Table 1), by defining the relationships and linkages more explicitly using the relevant scientific disciplines and their literature.

Box 1 – Coral reef SDG narrative in about 140 words, mentioning all 17 goals (goal numbers are cited between {}).

- Coral reefs {G14}, their health described by measures of coral and fish diversity and abundance, provide key services and benefits to people.
- These services directly support 10s of millions of jobs in multiple economic sectors {G8} in coastal and distant states, protect and harbor communities and cities {G11} across tropical coastlines, sustain use of living and non-living resources{G12}, provide transport infrastructure and valuable natural products {G9}, and in future may provide energy solutions {G7}.
- Through these multiple benefits, coral reefs contribute to reducing hunger {G2} and poverty {G1}, thus improving health {G3}, and potentially strengthening gender {G5} and social equality {G10}.
- However, access and use result in pressures that may drive decline in coral reef health. Broader land and seascape factors also affect reef health, including land-use change {G15} and altered freshwater flows {G6}, as well as climate change {G13}.
- Managing this complex system requires appropriate awareness and knowledge {G4}, governance mechanisms {G16} and investments by stakeholders {G17}.

Discussion

Thus a simple narrative model accessible for public and policy discourse, is linked to a scientific evidence-based framework that supports monitoring and management of this complex social-ecological system [30], on a firm foundation of sustainable development [27,31] and blue economy [5,6]. The value of this 'coral reef SDG model' is in its simplicity – expressing how and why natural assets are fundamental to multiple aspects of human economy and society, and to help express how blue economy and sustainable development intersect. Two main benefits of this model are:

Expressing common values [2] - first, having been endorsed by countries in the United Nations, the SDGs express the highest level of 'societal value' common to all countries and cultures across the planet. The 17 goals correspond broadly to the three pillars of sustainable development – environment, economy and society – as well as to governance and means of implementation (e.g. goals 16, 17) and pressures on the environment (e.g. goals 6, 13) that economy and society impose.

What you measure is what you manage [3,32] - second, the goals can be deconstructed (here in the context of a coral reef) into specific elements (e.g. fish, income or health), which are quantifiable through metrics and indicators. Taken together, the targets and indicators across multiple goals help quantify what is meant by 'sustainability', as to meet sustainability criteria each metric will need to fall within certain ranges. Thus overall sustainability would not be achieved if any one or set of indicators do not meet their criteria. The model makes the relationships between ecological, economic and social compartments explicit, as well as identifying whether interactions are causal or correlative. Thus monitoring of these compartments and relationships provides the data necessary for informing management as well as assessing its effectiveness.

Each of these, the 'global' and the 'local', are expanded on further below.

The local context

Developing an SDG narrative at local levels for individual value chains helps elucidate the complex interactions and change factors that need to be considered in management of coral reefs at a local level. Two case studies illustrate this, for fisheries and coastal protection, following the structure identified by the model (fig. 3, Table 2).

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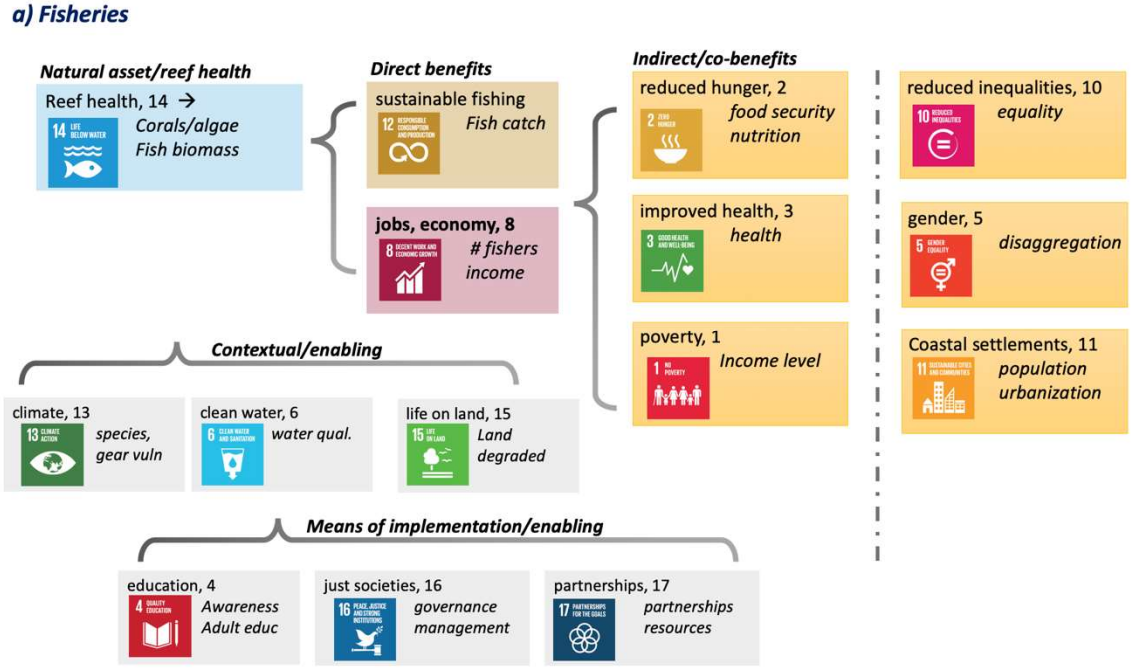
In both examples core relationships are relatively simple and direct, and each set of relationships can be measured by a variety of variables and indicators now relatively well established in natural and social sciences, and in relevant engineering and technology sectors. For example, interaction between the reef resource and fishers can be quantified by fish catch and/or income earned, or social dynamics may be illustrated through gender disaggregation of primary indicators such as fish catch or income earned. Indirect and secondary benefits (increasingly termed co-benefits [14,21,27]), the effect of social and enabling factors on coral reef health, and aspects of access to, utilization and management of the system, may be quite complex. These interactions may vary greatly from one location to another depending on local ecosystem dynamics, cultures and governance systems, and depending on the spatial scale at which the model is applied. Nevertheless, the common language of the model enables consistency among applications, as well as differentiation of the model to suit local contexts. The behavior and key thresholds for each variable may be identified empirically, or derived from the relevant literature, so the performance of each interaction can be assessed. For a holistic overview, aggregation can be done to varied levels, through multi-dimensional metrics.

Historically there has been greater investment in biophysical over socio-economic monitoring (e.g. for coral reefs [³3,34], in large part due to greater complexity and variation in human dimensions over natural ones [35]. Efforts to redress this have been varied, such as the SocMon programme of the Global Coral Reef Monitoring Network [36], and capacities for monitoring, data management and integration are improving to the point of making 'integrated monitoring' a reality [34,38]. The SDG model supports these efforts, not only helping to identify key components of the model and variables defining their interactions that monitoring programmes should measure, but also providing a bridge to societal benefit priorities motivating large scale aggregation [35,38]. The model may also facilitate integration of values and data from multiple knowledge systems and perspectives on nature [39,40], by enabling different stakeholder groups to populate the narrative model and linked mechanistic model (Fig. 2) with elements and measures important to their knowledge systems.



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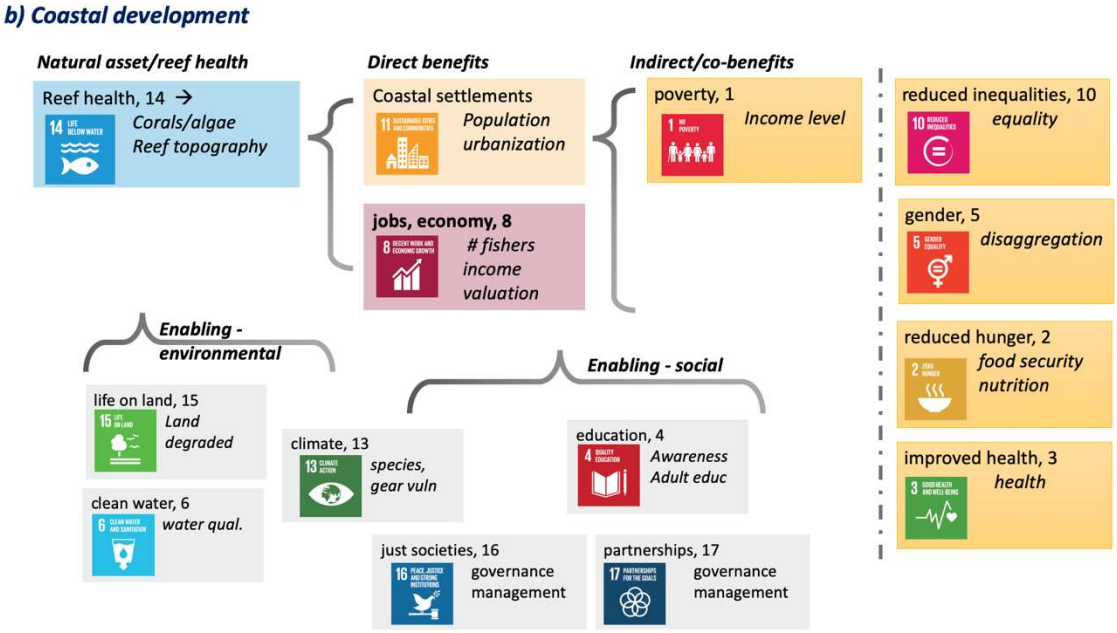

Figure 3. The coral reef SDG model parametrized for two examples of benefit flows: a) fisheries and b) coastal development. The number of each goal is given, with a suggested local indicator (and see Table S1).

Table 2. Coral reef SDG narrative adapted to fisheries and coastal development, corresponding to figure 3.

	Fisheries (see fig. 3a)	**Coastal development (see fig. 3b)**
Asset, ecosystem service provision	Fish and other marine life on coral reefs {G14} provide a renewable resource for extraction.	Coral reefs create physical structure {G14} that provide a wave barrier protecting the shoreline.
Direct benefits	Direct benefits are mediated through fish catch {G12}, supporting jobs, income and value chains {G8}.	This enables the development of settlements {G11} and economic activity {G8} on the shoreline, and natural waterways {G9} for navigation.
Cobenefits	These contribute directly to reducing poverty {G1}, and an increased or stable food supply {G2}. These directly (protein and nutrients) or indirectly (income) improve health {G3} and education {G4} in fishing households and communities, as well as affect gender {G5} and equality {G10}.	These affect income and poverty levels {G1}, with many contextual and covarying aspects across food security {G2}, health {G3}, equality {G10} and gender {G5}.
Enabling factors, pressures	The health and nature of a fishery is affected by environmental (climate {G13} and terrestrial/freshwater effects	Coastal development transforms land cover {G15} and freshwater dynamics {G6}, affecting the benefits derived

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	{G6,15}) and social (e.g. general education and awareness {G4}) factors.	from reefs. Other factors include climate {G13}, and general education and awareness {G4}.
Means of implementation	Fisheries need to be managed {G16}, require investment and participation by relevant actors {G17}, and are affected by general awareness and understanding among fishers and consumers, as well as managers and scientists {G4}.	Coastal development requires appropriate governance {G16} and public compliance affecting land-sea interactions {G11} and investment {G17}, and affects resource extraction {G12}.

The national and international context

Within countries, economic sectors have tended to develop in isolation, with little integration of metrics and data among them. Not only may different sectors use different methods and protocols for monitoring, they may use different variables for the same quantities. This hampers the development of multi-sectoral or integrated approaches. Thus, establishing a monitoring and evaluation framework for the SDGs is challenging. The indicator framework developed thus far [3], though ambitious, is hampered by this lack of integration, and in the absence of tangible common metrics has focused on process indicators (e.g. area covered by ecosystem based management measures for 14.2) rather than physical variables (e.g. of ecosystem health measures, such as coral cover) [32].

The SDG indicator framework identifies indicators at three levels of indicator maturity, from low (Tier 3) to operational (Tier 1) [3], paralleling the 'readiness' framework of essential ocean variables [34,41], providing practical steps guiding how these indicators can be matured and made more ready for use. However, many of the proposed SDG indicators are not relevant to local contexts, or cannot readily be equated with more tangible/local indicators (Table S1). The model proposed here facilitates the identification of locally relevant and 'real' Indicators (e.g. coral reefs managed and in healthy state, as shown by coral, fish and other indicators) that could be aggregated through higher level proxies (e.g. proportion of coral reef area under ecosystem-based management, for Target 14.2) to populate the official SDG indicators framework that countries must use to report on the SDGs [42].

A similar challenge is evident from experience with the 2011-2020 Strategic Plan for Biodiversity of the Convention on Biological Diversity. This plan was concretized through 20 targets (the Aichi Biodiversity Targets), and there has been mixed success in reaching them. Those closest to being achieved [43] are primarily process-oriented (e.g. Target 2.1 - 'Biodiversity values integrated into national and local development and poverty reduction strategies'). Those farthest from being achieved, or even suffering regression (e.g. Target 10.1 – 'multiple anthropogenic pressures on coral reefs are minimized, so as to maintain their integrity and functioning') refer to actual drivers of decline but without any mechanism or mandate for the CBD to address them directly. This weakness has led to a call for a more comprehensive framework for the post-2020 CBD targets, though it is currently not yet clear what form such a framework may take [44]. This model provides a solution, specifying how targets for the status of nature, which are the focus of the objective 1 of the convention (on nature conservation), integrate with the other goals that relate to objectives 2 and 3 of the convention, on sustainable use and benefit sharing, as well as to means of implementation. The post-2020 CBD framework may consider use of this model not only to provide a framework for integrating biodiversity and social targets, but also to assure consistency with the SDGs and their joint application from 2021 to 2030. A proposed pyramid framework tabled at the first meeting of the Open Ended Working Group of the CBD held from 27-30 August 2019 in Nairobi, Kenya (Fig. 4), provides a relevant framework to superimpose the groups of goals relating to a potential apex target on biodiversity, direct and indirect/co-benefits, and means of implementation.

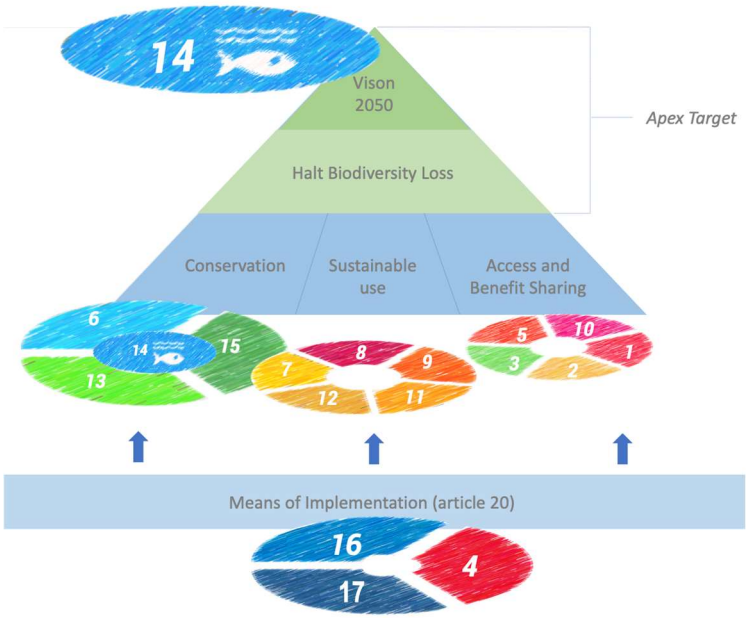

Figure 4. Proposed pyramid framework tabled at the 1st Open Ended Working Group of the Convention on Biological Diversity (CBD) held from 27-30 August 2019 in Nairobi, Kenya, by Brazil. This is superimposed with the SDG goal components of the coral reef SDG model, comprising the apex target (here focused on a coral reef), and the focus area of each goal of the CBD, on conservation (biodiversity goals), sustainable use (direct benefits), access and benefit sharing (indirect benefits) and means of implementation. Further elucidation of both the coral reef model and the proposed pyramid framework may result in a final 'integrated target framework' that is being sought for the post-2020 CBD framework aligned with the Sustainable Development Goals.

Formal implementation of the SDGs has to use the specified targets and indicators [3]. This model provides an informal framework for 'soft' implementation and assessment of sustainability, where context-specific indicators and targets can be identified that meet the local context, yet make it clear the spirit of the SDGs is being followed (Table S1). This enables different stakeholders to document and assess how well their actions support (or not) implementation of the SDGs. These 'soft' metrics may be particularly useful to assess Voluntary Commitments [45], which vary greatly in nature, and for non-government partners, for whom the SDG headline indicators may not be relevant. This model may also be useful at sub-national levels, or adapted across different ecological systems, for example mangrove, seagrass and nearshore pelagic systems, or even terrestrial ones. It may help countries to aggregate from local to higher levels, then translate the results into the high level indicators contained in the IAEG indicator framework for national reporting.

Conclusion

A model helps to make key relationships explicit, which is particularly useful in a complex context such as the nature-society domain of the Sustainable Development Goals. This model deconstructs the nature-society interactions in the 17 domains of the goals, by identifying key interactions within and across them, and thereby metrics that quantify them. This enables target-setting based on knowledge of these interactions and their inherent thresholds or limits, and the design of targeted monitoring to inform management and governance of the system. With nature as the entry point (a particular coral reef ecosystem service) the approach is equivalent to 'ecosystem-based management' [46] or in the specific case of fisheries, the 'ecosystem-approach to fisheries' [47]. This paper has focused on coral reefs as a model system, but can be applied in any land- or seascape. Equally, the model may potentially be constructed from the perspective of any of the 17 goals, for example health (goal 3) – in which case

it may express a 'health-approach to the SDGs', or may even be applied to focus on a narrower challenge, such as a 'health-approach to fisheries'.

So long as the model is applied in a way that meets the vision of stakeholders in each goal, it enables a consistent approach across wide domains of economic and social sectors. The SDGs can therefore be used not just as a static framework, or just to look at interactions among goals [28], but as a way to view all goals from the perspective of any interest holder, and thereby develop fully integrated approaches to development that are coherent and complementary with one another. Viewed through SDG14 (i.e. an oceans perspective) the model provides a tangible way to forge equivalence between 'blue economy' and the SDGs [6]. It also identifies specific requirements for monitoring, how science and knowledge can be used, and helps identify gaps [34,48]. Among countries, where formal joint management may be impossible, commitment to the SDGs and application of a common model [2] could help assure alignment and mutually supportive actions [49,50]. In regions with many countries this may also be helpful, enabling collective action without requiring over-complex multi-country agreements.

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Table 1. The 17 Sustainable Development Goals (SDGs) interpreted for their dependence on coral reefs, and effects on coral reefs, within a coral reef land- or seascape. The goals are interpreted for the strength and direction of their interactions.

SDG	Title	Affected by 14 (coral reefs)	Effect on 14 (coral reefs)	Metrics/indicators, comparison with non-CR areas, gradient of SDG14 metrics
14	Life below water	This is the 'home' goal for coral reefs (CR) with target 14.2 (ecosystem health) being the primary measure of ecosystem health.	-	The Essential Ocean Variables (EOV) coral cover, fish abundance and macroalgae canopy cover.
Direct benefits				
12	Responsible consumption and production	Consumption of ecosystems services falls under this goal (e.g. fishing, tourism). CR are a major supporter of consumption/ production. **Strongly positive**.	The type of consumption/production impacts on CR ecological function and resilience. **Potentially strongly negative**.	Usage metrics (e.g. fish catch, bed-nights) relevant to each service, with relevant thresholds for over-exploitation
8	Decent work and economic growth	Jobs and livelihoods, income, economic sectors and economic growth supported by CR services. **Strongly positive.**	The type of consumption/production impacts on CR ecological function and resilience. **Potentially strongly negative.**	Number of jobs and/or businesses by sector, metrics of sustainability by jobs/sector
9	Innovation and infrastructure	Biologically active chemicals for e.g. medicine, genetic resource potential, basic/applied research and transport/other potential infrastructure may all be enhanced by health reefs. **Positive**.	Potential negative impacts of innovation and infrastructure on CR. **Potentially negative.**	Number and types of innovation product/ activities/ projects, income/jobs in these, potential impact metrics
11	Sustainable cities and communities	Shoreline protection for cities and urban areas, villages and communities. **Strongly positive.**	Impacts on water quality and coastline hardening, exacerbated by sea level rise. **Generally strongly negative**	Human population, population density, urbanization indicators, coastal hardening

7	Clean energy	Ocean and coastal energy sources are all physical (wind, solar, wave, tides, currents) so not directly influenced by CR health. **Neutral**.	Substitution of fossil fuels reduces carbon dioxide emissions, energy installations may have positive or negative impacts locally, support for consumption may be negative. **Both positive and negative.**	Energy installations (dimensions, size, location, power generation), environmental impact measures
Coral reefs support via indirect/co-benefits				
1	No poverty	Ecosystem services directly support incomes across multiple economic sectors, including fisheries, tourism and others. **Strongly positive.**	Poverty may impose strong impacts on CR ecological function and resilience. **Potentially strongly negative**.	Cash income from CR services, proxy indicators of wealth/income.
2	Zero hunger	Ecosystem services directly reduce hunger through provision of fish, and through providing jobs and raising incomes. **Strongly positive.**	Low food security may impose strong impacts on CR ecological function and resilience. **Potentially strongly negative**.	Fish consumption per capita, fish catch retained by fishers, total food consumption at household level.
3	Good health and well-being	Ecosystem services directly improve health and well-being through multiple pathways, including fish protein, reduced hunger, reduced poverty. **Strongly positive.**	Unclear relationship between health outcomes on land and coral reef health. **Uncertain.**	Standard health metrics.
5	Gender equality	Improved gender equality may improve engagement and action by stakeholders, and improved management. **Positive**.	Gender equality may improve management of coral reef health. **Likely positive.**	Standard gender metrics and disaggregation of other indicators.
10	Reduced inequalities	Equality among countries and societal sectors may be improved in CR areas. **Positive.**	Societal equality may improve management of coral reef health. **Likely positive.**	Standard equality metrics, measured in CR areas
Enabling environmental factors				

6	Clean water and sanitation	Improved sanitation (land-based runoff) reduces liquid waste delivery to reefs, resulting in improved environmental conditions. **Strongly positive.**	Coral reef action does not directly reflect back onto freswhater conditions. **Neutral.**	Nutrient flows into coral reef areas, metrics of sanitation
15	Life on land	Coastline and watershed/ridge-to-reef interactions between land and sea strongly impact on coral reefs. **Strongly positive.**	Coral reef action does not directly reflect back onto land conditions. **Neutral.**	Land cover and uses, degree of alteration, water and/or nutrient/waste delivery to CR waters (and see goal 6). Restoration actions may have storng positive influence on CR health.
13	Climate change	Climate change and ocean acidification have strong negative impacts on corals and other reef biota. **Strongly positive.**	Coral reef action does not affect carbon balance, but awareness of coral reef impacts strongly promotes climate action. **Neutral to positive.**	Thermal stress, acidification and other relevant climate metrics; measures of acclimatization/ adaption of corals, etc.
Affect coral reefs ….				
16	Justice and strong institutions	Management and regulatory mechanisms, including traditional and local institutions, focused on coral reefs, as well as the overall social-ecological system. **Strongly positive.**	Coral reefs a flagship system that may help to improve governance for coral reefs, and for other systems. **Potentially positive.**	Governance metrics, specifically of CR management and/or more generally of national/local government
17	Partnerships	Partnerships, including resource mobilization and support for the primary actors. **Strongly positive.**	Coral reefs a flagship system that may help to build partnerships and support, for coral reefs, and for other systems. **Potentially positive.**	Partnership and resource mobilization metrics
4	Quality education	Improved education may improve engagement and action by stakeholders, and improved management. **Strongly positive.**	Coral reefs a flagship system that may help to improve education and training, for coral reefs, for other systems and public awareness. **Potentially positive.**	Education and awareness metrics

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Supplementary material

Table 1. – mapping of headline indicators and coral reef indicators for fisheries example.

Fisheries (fig. 3a)	*Headline indicators*	*Coral reef/local level indicators*
Asset, ecosystem service provision – Fish and other marine life on coral reefs	14.2.1 Proportion of national exclusive economic zones managed using ecosystem-based approaches 14.5.1 Coverage of protected areas in relation to marine areas	Proportion of coral reefs managed and in healthy state, as shown by coral, fish and other indicators. Proportion of coral reef/fishery grounds under strict protection as fishery replenishment reserves
Direct benefits – Direct benefits are mediated through fish catch {G12}, supporting jobs, income and value chains {G8}.	12.1.1 sustainable consumption and production (SCP) national action plans 12.2.2 Domestic material consumption, 8.4.1 Material footprint,	Fishery management plans Fish catch (kg, per capita)
	8.3.1 Proportion of informal employment in non-agriculture employment, by sex 8.5.1 income/earnings of female and male employees	Number of fishing jobs, by gender Income of fishers and others in fish value chains, by gender.
Cobenefits – These contribute directly to reducing poverty {G1}, and an increased or stable food supply {G2}. These directly (protein and nutrients) or indirectly (income) improve health {G3} and education {G4} in fishing households and communities, as well as affect gender {G5} and equality {G10}.	1.2.1/1.2.2 Proportion of population living below the national poverty line (multiple indicators)	Proportion of coastal (coral reef area) residents living below national poverty line (multiple indicators)
	2.1.2 Prevalence of moderate or severe food insecurity in the population 2.3.1 Volume of production in farming/pastoral/forestry enterprise size 2.3.2 Average income of small-scale food producers	Measures of food insecurity in coral reef/coastal communities Fish production Income of small-scale fishers
	3.3.3 Malaria incidence per 1,000 population 3.8.2 Proportion of population with large household expenditures on health	Malaria incidence per 1,000 population Proportion of population with large household expenditures on health
	4.1.1 children and young people formal education	School attendance rates in coral reef/coastal communities

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	4.3.1 youth and adults in formal and non-formal education and training; 4.7.1 Extent of education for sustainable development mainstreamed	Adult and fisher participation in continuing/ sustainable fisheries education
	5.1.1 legal frameworks on non-discrimination on the basis of sex 5.5.2 Proportion of women in managerial positions 5.b.1 Proportion of individuals who own a mobile telephone, by sex	Fishery laws/management plans with dealing with gender representation Proportion of women in leadership positions in fisheries sector Proportion of fishers and fish processors who own a mobile phone, by gender
	10.2.1 Proportion of people living below 50 per cent of median income	Proportion of coral reef/coastal community living below 50 per cent of median income
Enabling factors, pressures – The health and nature of a fishery is affected by environmental (climate {G13} and terrestrial/freshwater effects {G6,15}) and social (e.g. general education and awareness {G4}) factors.	13.2.1 integrated strategies for adaptation, climate resilience and low greenhouse gas emissions 13.b.1 specialized support in least developed countries and SIDS, for raising capacity	Coral reef and fishery management plans with climate adaptation and resilience Investment and support for capacity building in climate adaptation and resilience in coral reefs and fisheries
	6.3.1 Proportion of wastewater safely treated; 11.6.1 Proportion of urban solid waste regularly collected 6.3.2 Proportion of bodies of water with good ambient water quality	Proportion of householders/businesses with wastewater treatment Proportion of rivers and lakes draining into coral reef area with good water quality
	15.3.1 Proportion of land that is degraded over total land area	Proportion of coastal land that is degraded.
Means of implementation – Fisheries need to be managed {G16}, require investment and participation by	16.5.1/2 Proportion of persons/groups who faced public sector corruption 16.6.1 Primary government expenditures as a proportion of original approved budget	Proportion of fishers/processors who faced fishery sector corruption Primary government expenditure in fisheries sector, as proportion of original budget

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relevant actors {G17}, and are affected by general awareness and understanding among fishers and consumers, as well as managers and scientists {G4}.	16.7.2 Proportion of population who believe decision-making is inclusive and responsive	Proportion of fishers/processors who believe decision-making is inclusive and responsive
	17.1.1 Total government revenue as a proportion of GDP, by source; 17.3.1 Foreign direct investment (FDI) 17.6.1 Number of science and/or technology cooperation agreements and programmes 17.9.1 financial and technical assistance committed to developing countries 17.16.1 countries reporting progress in multi-stakeholder development effectiveness monitoring frameworks 17.18.1 Proportion of sustainable development indicators at national level 17.18.3 Number of countries with a national statistical plan that is fully funded and under implementation, by source of funding	Total revenue from fisheries, government and other sources spent in fisheries management Number of management plans with science and technology inputs and programmes Financial and technical assistance committed to capacity building in fisheries Number of multi-stakeholder partnerships in coral reef fisheries Sustainable development indicators produced in relation to local sustainability Completeness of fisheries statistical plan, including monitoring and data collection
	(Aichi Targets)	Proportion of fishery stakeholders and the general public aware of sustainability management needs Incorporation of science and knowledge in management planning and policy for fisheries.