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Mapping the linkages between oceans and other Sustainable Development Goals: A preliminary exploration

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ABSTRACT

This paper maps interrelationships among targets of the Sustainable Development Goal dedicated to oceans (SDG 14), as well as interrelationships between those targets and other SDGs. This is done using a large number of UN reports as well as scientific publications. The literature identifies many linkages among the targets of SDG 14; most of these targets are potentially synergistic with one another. Many linkages also exist between SDG 14 targets and other SDGs. Different targets under SDG 14 link to different SDGs. This has implications for policy discussions on how to achieve progress on SDG 14. The interrelationships that we highlight can be used as a tool for dialogue between policy and scientific communities working on oceans, in particular for assessing the status of knowledge on the various linkages, as well as identifying linkages that are likely to matter most for progress on SDG 14.

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1 Introduction

Since the adoption of a new universal agenda for sustainable development by Member States of the United Nations in September 2015, efforts have multiplied to better understand the linkages and interrelationships that exist among the Sustainable Development Goals (SDGs). This is seen to be necessary in order to devise integrated strategies and policies that foster synergies across different goals and explicitly address tensions and potential trade-offs among them.

In 2015, the International Council for Science (ICSU) and the International Social Science Council (ISSC) published a study documenting linkages among all the SDG targets and other goals (ICSU and ISSC, 2015). The editions of the UN Global Sustainable Development Report published in 2015 and 2016 adopted the SDGs as an integrated network of goals as their basic framework (United Nations, 2015 and 2016a). Generic network maps of the SDGs were proposed in Le Blanc (2015). Systematic lists of relationships among the targets under one SDG and other SDGs have been published for SDG6 (UN-Water, 2016), SDG4 (Vladimirova and Le Blanc, 2016), and similar work is ongoing in other SDG areas (ICSU, forthcoming). The International Resource Panel has explored the links between natural resources and SDG targets (UNEP, 2015a). The latest Global Education Monitoring report is entirely devoted to the relationships between SDG4 and other SDGs (UNESCO, 2016). Studies of interrelationships among targets within specific clusters of SDGs have also been published (for example, Weitz and Nilsson, 2014, for climate, land, energy and water).

As far as we are aware, a similar systematic exercise has not yet been undertaken for oceans – SDG 14. This paper intends to fill this gap. We aim to identify important interrelationships that exist among SDG 14 targets, as well as with other SDG areas. The objective is to provide a frame for describing policy issues in relation to the various targets under SDG 14, which can be used to document the state of knowledge that exists on different linkages, both from the scientific and policy points of view.

The work presented in this paper aims to inform the preparation of the forthcoming intergovernmental conference on the implementation of Sustainable Development Goal (SDG 14), "conserve and sustainably use the oceans, seas and marine resources for sustainable development", which will be held in June 2017.[1] Looking at the ten targets listed under SDG 14 (see Box 1), it readily appears that their realization will be impacted by many factors, both within and outside the "ocean sphere". Taking these factors into account is going to be critical in devising strategies to progress on these targets and on SDG 14 more generally. What this paper aims to do is to clarify, in a consistent way across SDG 14 targets,

1 The stated goals of the conference are to: Identify ways and means to support the implementation of Sustainable Development Goal 14; build on existing successful partnerships and stimulate innovative and concrete new partnerships to advance the implementation of Goal 14; share the experiences gained at the national, regional and international levels in the implementation of Goal 14; and contribute to the follow-up and review process of the 2030 Agenda for Sustainable Development. The conference is mandated to involve all relevant stakeholders to assess challenges and opportunities relating to, as well as actions taken towards, the implementation of Goal 14. See United Nations General Assembly resolution A/70/L.64.

the interrelationships that exist among them, as well as with other goals. This is done using a large number of UN reports and scientific publications. We synthesize the results of this research in tables showing interrelationships of each of the ten SDG 14 targets with other SDGs.

While some level of detail regarding the nature of the links and the channels through which they operate are given in the text below, the tables we present intend to stay at the "meta" level, by giving a general idea of the nature of the linkages that exist. They are intended as "hooks" upon which scientific and policy literature relative to specific linkages can be situated within the context of each SDG 14 target, for example to produce SDG-relevant science and knowledge maps. We think that the value added of the tables resides in their representation of ocean-related issues in relation to other SDG areas, which provides a bridge for communities working on various sustainable development fields to engage. We feel that this is necessary for policy-making, both at a broad level such as that of an international conference on oceans

Box 1
SDG 14 targets

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution

14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans

14.3 Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels

14.4 By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics

14.5 By 2020, conserve at least 10 per cent of coastal and marine areas, consistent with national and international law and based on the best available scientific information

14.6 By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing and refrain from introducing new such subsidies, recognizing that appropriate and effective special and differential treatment for developing and least developed countries should be an integral part of the World Trade Organization fisheries subsidies negotiation

14.7 By 2030, increase the economic benefits to small island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism

14.a Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries

14.b Provide access for small-scale artisanal fishers to marine resources and markets

14.c Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in the United Nations Convention on the Law of the Sea, which provides the legal framework for the conservation and sustainable use of oceans and their resources, as recalled in paragraph 158 of "The future we want"

and at the national level, where much policy-making in relation to oceans occurs.

The remainder of this paper is built as follows. Section 2 describes the methodology used in our analysis. In section 3, we describe the interrelationships among the ten targets of SDG 14. Section 4 describes linkages among individual targets of SDG 14 and other SDGs. Section 5 concludes.

2 Methodology

Studies documenting the linkages among SDGs have adopted different methodologies. Depending on the case, they are more or less explicit on how linkages are defined, and on the sources chosen to identify them (e.g. scientific literature, various types of reports, expert assessments, mixed sources). Some include a classification of links into qualitative categories that aim to refine the notion of synergy and trade-off (e.g. Weitz and Nilsson, 2014; Nilsson et al., 2016, ICSU, forthcoming). Others focus on positive and negative feedbacks from one goal or target to another, in the spirit of systems analysis (Vladimirova and Le Blanc, 2016; UN, 2015, chapter 3).

The methodological choices we made were based on the primary objective to produce maps that can be used both as frames for comprehensive policy discussions of each of the targets under SDG 14 and as skeletons for science maps in relation to those targets. Specifically, we chose to work on tables that show directional linkages.

The tables were constructed in an interactive way. We selected 124 reports from the United Nations system and other international organizations and systematically collected material therefrom that referred to oceans (based on a list of keywords) and other SDGs.[2] In parallel, as a benchmark, we started to draw maps of the interrelationships between individual targets of SDG 14 and the rest of SDGs, based on the authors' knowledge of policy issues surrounding oceans in international negotiations since the Earth Summit, and previous assessments of the scientific literature (UN, 2015, chapter 3; UN, 2016b). The comparison of these two analyses showed that the material coming from our sample of reports was covering only a fraction of existing linkages, often at a broad level of generality. This pointed to the need to broaden the scope of our source material. To this end, we conducted a limited analysis of the scientific literature on oceans. The linkages that are included in the tables are those for which we found references in the literature. It is clear, as pointed by one of the referees, that investing more resources in a search of the literature would likely yield an even greater number of linkages than are documented here. This has to be kept in mind when reading the paper.

An important exception to this approach is that our tables do not systematically include linkages with SDG 17, which refers to the so-called "means of implementation". The dimensions that SDG 17 encompasses (finance, capacity building, trade, information and communications technology and data, monitoring and accountability) are relevant to most of the targets under SDG 14. In particular, financing and capacity building have been identified as important across the set of SDG 14 targets (UN, 2017). We do refer to trade for specific targets for which it is especially relevant. The same applies to SDG 16, and in particular target 16.6 that refers to "effective, transparent and accountable institutions at all levels". From the literature, it is clear that this is a critical factor which will affect the realization of most of the targets under SDG 14. This should be kept in mind when interpreting the tables.

In documenting the interrelationships, choices had to be made regarding the translation of individual SDG targets into elements that are suited for a systems analysis. This is by no means trivial. To give an example, target 14.3 reads: "Minimize and address the impacts of ocean acidification, included through enhanced scientific cooperation at all levels". While the stated objective of this target is a containment of acidification as a threat to oceans, in the scientific literature the concept used is rather acidification itself.

2 The list of keywords is available from the authors upon request.

Choosing one or the other will change the nature of the links (positive vs. negative) that we map. The same applies for pollution, which is the subject of target 14.1. In both cases, we chose to use the threat itself, i.e. "pollution" and "acidification", rather than "Reduce pollution" and "reduce acidification".

Another difficulty is the treatment of targets such as 14.2, "By 2020, sustainably manage and protect marine and coastal ecosystems etc." The "sustainable" character of the management of marine ecosystems is a matter of appreciation, with many competing criteria associated to it – environmental ones, but also economic and social. Different disciplines will tend to focus on specific dimensions. To address this issue, we chose to base the description of links from and to target 14.1 on the concept of "marine and coastal ecosystem management", without presuming of the "sustainable" character of it, but with the understanding that to be truly sustainable, management will need to encompass environmental, social and economic sustainability.

Yet another difficulty is with target 14.6, "By 2020, prohibit certain forms of fishery subsidies which contribute to overfishing etc." In this case, the formulation of the target itself clearly reflects that the definition of the subsidies that should be included in this target is very contentious. As discussed below, there are many types of fisheries subsidies, and their impacts vary widely. We chose to label this target simply as "fisheries subsidies", being understood that this limits the inferences that can be made based on the tables.

While the ocean is global in scale, the various linkages documented here apply to different geographic scales. Some are local in nature; others are national; still others are regional or global. This distinction is important when it comes to translating the impacts of links into policy. Therefore, we summarily document the geographic scale of the various links in the tables below. It is worth noting that in many of the "national" entries in the tables, actions occurring in one country may have consequences on other countries – for example for pollution but also for social and economic outcomes. We illustrate this potential for trans-boundary effects in Table 1, as an example.

A last point worth mentioning is that in many cases, feedbacks from one goal or target towards another cannot be assigned an unambiguously positive or negative value. For example, depending on how it is designed and implemented, protection of coastal and marine areas could benefit or hinder access to marine resources for small-scale fishing communities. Evaluations from different locations are likely to document a range of outcomes in this respect. It is beyond the scope of this paper to identify such cases in a systematic manner. We point to select examples in the text that accompanies the tables. Additionally, for some targets, there may be potential links to other targets that cannot be characterized simply. This is especially the case with targets relating to international law. While the latter may potentially impact many of the other targets, it may not have been sufficiently developed for such impacts to be felt in practice; it may not be implemented, or may be implemented differently across locations. This applies in particular to legislation relating to fisheries and to the United Nations Convention on the Law of the Sea (UNCLOS) in general.

The comments in the text aim to illustrate selected linkages, with some reference made to published literature. This should in no way be understood as reflecting a complete investigation. We try to acknowledge debates or controversy when they are known to us. However, it is clear that providing a complete and fully balanced description of the scientific debate on each of the linkages would in itself be a massive undertaking. Inevitably, the approach by target gives rise to potential repetitions – for example, many arguments applying to sustainable ecosystem management (target 14.2) also apply to fisheries (target 14.4) or to conservation (target 14.5). In order to avoid repetitions, we address each issue only once. Therefore, while the tables documenting the linkages aim to be as complete as possible, the accompanying texts are not. This should be kept in mind when reading the paper.

3 Interrelationships among the ten targets of SDG 14

SDG 14 is composed of the ten targets. Three of the ten targets refer to oceans as ecosystems: targets 14.2, 14.4 and 14.5. Two targets focus on important threats to oceans: 14.1 on pollution, and 14.3 on ocean acidification. Three targets relate to the economy surrounding the oceans, with focus on fishery subsidies (14.6), access for small-scale artisanal fishers to marine resources and markets (14.b), and benefits for small island developing States (SIDS) and least developed countries (LDCs) (14.7). Target 14.a refers to scientific knowledge and transfer of technology. Lastly, target 14.c refers to the implementation of international law as reflected in UNCLOS. Many of these are adaptations of pre-existing targets that figured in other pieces of international legislation, such as the Johannesburg Plan of Implementation (for example, target 14.4 on sustainable fisheries) or the Aichi Targets (for example, target 14.5 on protection of marine and coastal areas). But relatively "newer" targets were also introduced, such as target 14.7. At the same time, the targets do not include other dimensions that are important in the context of the SDGs. For example, ocean acidification is the only by-product of greenhouse gas emissions that was included as a target. Impacts of climate change such as sea level rise, ocean warming, changes in ocean circulation and salinity, which will have a range of impacts on SDG 14 and other SDG areas, are not part of the targets (UNDESA et al., 2014; ESCAP, 2016).[3]

Figure 1 maps important linkages among the ten targets under SDG 14. Because of the complex dimensionality of the interactions among the targets when viewed socially, economically and environmentally, the arrows in Figure 1 should be taken as illustrative but not definitive. From the examination of the map, it is clear that there are strong interdependences among the targets. However, in many cases the "real life" impacts of what is done in a target area on other target areas is variable, and can be positive or negative. Some targets are mostly at the "receiving end" of the interlinkages and are affected by many of the other targets. They include targets 14.2 (sustainable management of marine ecosystems), 14.4 (restoration of fish stocks), and 14.7 increased benefits for SIDS and LDCs. On the other hand, targets 14.a (science and technology) and 14.c (implementation of international law) have the potential to affect most of the other targets.

For example, target 14.c calls for the implementation of international law as reflected in UNCLOS. Its provisions set out the legal framework within which all activities in the oceans and seas must be carried out, and it could thus be argued that UNCLOS relates to almost all SDG-14 targets. Of particular relevance is the legal framework for the protection and preservation of the marine environment set out in Part XII of UNCLOS. It sets out the general obligation for States to protect and preserve the marine environment (article 192), and includes a number of provisions which elaborate on this obligation. These two parts relate directly to targets 14.2 and 14.5, but also to 14.4. UNCLOS also requires States to take, individually or jointly as appropriate, all measures consistent with UNCLOS that are necessary to prevent, reduce and control pollution of the marine environment from any source, using for this purpose the best practicable means at their disposal and in accordance with their capabilities (article 194) – these measures include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life (articles 194(3) and 212). This section links directly to SDG 14 targets 14.1, 14.2 and 14.4. UNCLOS also provides an extensive framework for marine scientific research and the development and transfer of marine technology (SDG target 14.a). It provides that States shall promote the development of the marine scientific and technological capacity of States which may need and request technical assistance in this field, particularly

3 Although it could be argued that increasing the adaptive capacity of ecosystems to cope with impacts of climate change is covered under the "strengthening their resilience" component of target 14.2

developing States, including landlocked and geographically disadvantaged States. These and other provisions in UNCLOS could positively impact the benefits that SIDS and LDCs derive from the use of marine resources (target 14.7).

The following are other illustrative examples of interdependencies. Reduction of marine pollution is critical for the conservation and sustainability of the oceans, seas and marine resources. Healthy fish stocks are negatively affected by pollution and contamination, which can lead in extreme cases to 'dead zones' devoid of marine life (Ramsar and UNWTO, 2012).

Marine and coastal areas are vulnerable to the pollution from land- and marine-based activities, including from urban areas that have limited wastewater infrastructure and release sewage untreated (UNEP, 2010, 2012). Land-based activities affect the runoff of pollutants and nutrients into coastal waters and remove, alter, or destroy natural habitat. Pollution also affects the protection of marine and coastal areas. Pollution and ocean acidification negatively affect benefits to SIDS and LDCs from the exploitation of natural resources. LDCs often have limited abilities to manage land-based sources of pollution. SIDS often have limited ability to manage pollution from ships (for example, cruise ships). The flow of pollutants into coastal waters has many negative impacts on livelihoods of coastal communities.

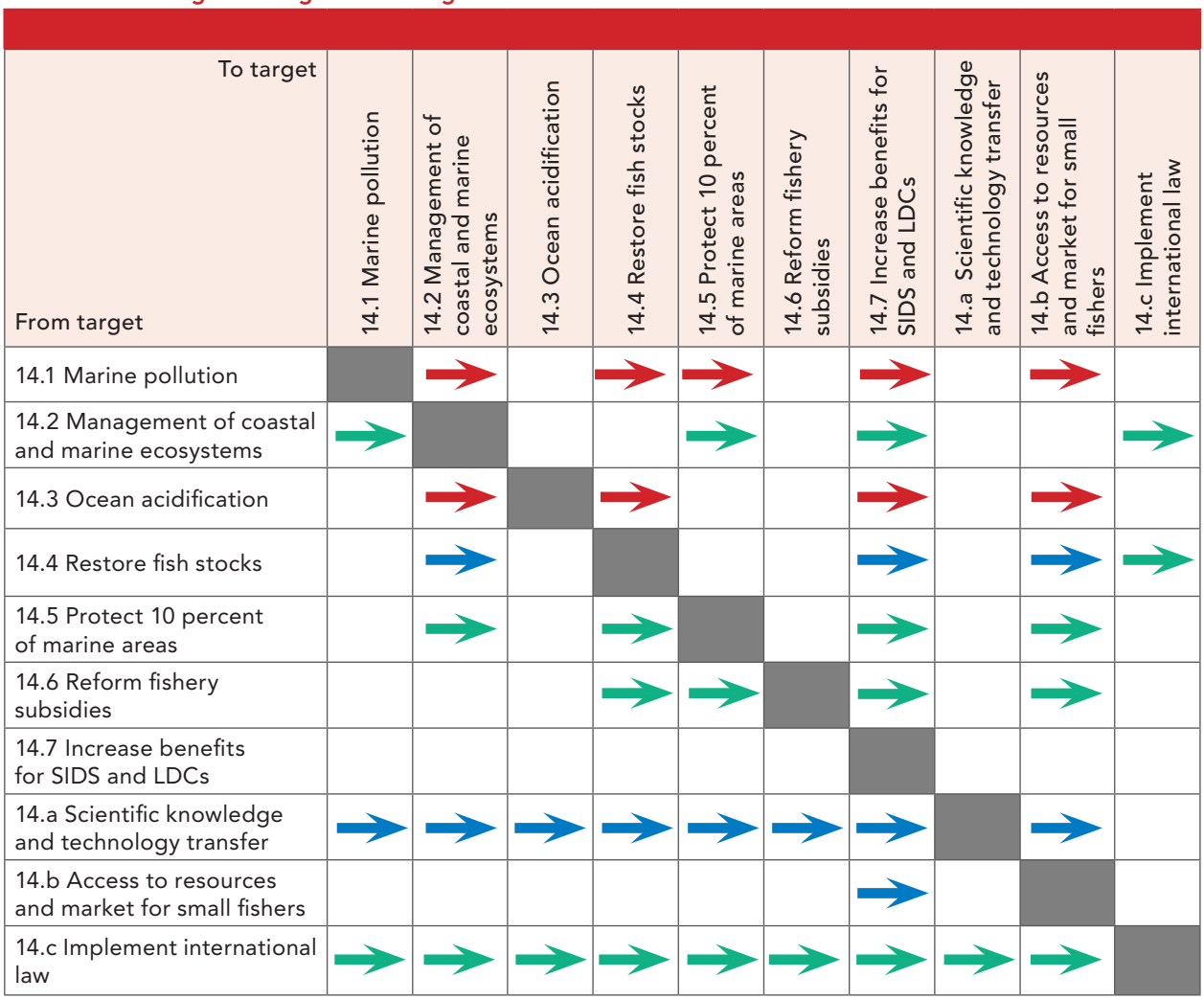
Ocean-based activities such as fisheries extract resources, add pollution, and change species composition, thus creating a linkage between the achievement of target 14.2 and target 14.4. Ocean acidification combined with effects of climate change can result in interactive, complex, and amplified impacts for marine species and ecosystems, such as coral reefs, which could bring significant biodiversity and economic losses (IPCC, 2014; World Bank, 2010, 2012; ESCAP, 2016; IAASTD, 2009; UNEP, 2012b; UNDP, 2014). Acidification reduces access to resources in two ways. The absolute amount of resources is reduced, especially in biogenic habitats like coral reefs, and the resilience of the ecosystems is also reduced, so that resources that are left can only sustain reduced rates of exploitation. Local communities experience those limitations most directly.

The fisheries sector is particularly important for SIDS. For example, estimates suggest that the tuna fishery industry alone provides 6-8% of all wage employment in the Pacific, with about 10,000 Pacific Islanders formally employed on tuna vessels and 21,000-31,000 people directly and indirectly employed in tuna-related jobs. Sustainable management of local fisheries for migratory fish stocks is therefore critical for long-term employment opportunities (UNDESA et al., 2014).

Despite local success stories from integrated coastal and marine area management and marine protected areas (MPAs), biodiversity in coastal areas continues to decline with intensifying pressures. Many areas that are protected are located in remote areas away from commercial activities and thus fail to protect the species, communities and habitats most threatened (UN, 2016b). Many MPAs do not to reach their full potential because they fail to consider local livelihoods, are affected by illegal harvesting, regulations that legally allow detrimental harvesting, or emigration of animals outside boundaries because of continuous habitat or inadequate size of reserve. While management ineffectiveness remains one of the largest problems facing the current MPA system, equity and the need to share benefits of the MPA locally are also key factors. In addition, there is a large amount of literature documenting that unless MPAs are integrated into broader management planning for coastal and marine areas, they are unlikely to meet their ecological, social and economic objectives (see the discussion in section 4.5 below for references).

In the same vein, the linkages between marine conservation (SDGs 14.1 and 14.5) and economic benefits to SIDS and LDCs (SDG 14.7) are greatly dependent on the design and governance of the MPAs and other management tools applied. Some MPAs provide benefits to communities through tourism revenue and increased fish catches from spillover effects. They may also empower communities through

Figure 1
Illustrative linkages among SDG 14 targets



Source: Authors' elaboration.
Note: Arrows indicate linkages from targets in the first column to other targets. Blue: positive link/ potential synergy. Red: negative link/ potential trade-off. Green: variable.

co-management or community-based management arrangements. But poorly governed and designed MPAs may also disrupt traditional livelihoods and change existing economic and social structures, including through redistribution of access rights, wealth and jobs. For the same reasons, the linkages between SDG 14.5 and 14.b relating to access for small-scale artisanal fishers can be either positive or negative depending on governance (FAO, 2011).

Capture fisheries have multiple impacts on marine ecosystems. The World Ocean Assessment documents such effects, which include: effects on target species; effects on other species through change in marine food chains; effects on non-target species as a result of by-catches; perturbation of habitat and perturbation of seabed (benthic) communities; and others (UN, 2016b). Therefore, fisheries affect the way marine and coastal ecosystems are managed.

Small-scale fishing communities are very vulnerable to the major threats to healthy oceans, including pollution, environmental degradation, climate change impacts and natural and human-induced disasters (UNEP, 2012a). Small-scale fish handling and processing generate waste inputs (water, fuelwood, etc.),

which could be reduced through the promotion of environmentally sustainable practices within an ecosystem approach (FAO, 2014a). In some places, small-scale fishers also undertake activities to protect marine environment from land-based impacts, for example by planting trees in watersheds to prevent erosion (United Nations University, 2011). Thus, small-scale fishers are not only dependent on a healthy marine environment, but interact with the environment in various ways.

The effect of fisheries subsidies on fish stocks can be positive or negative, depending on the intended effect and on the design of the subsidy – whether intended to maintain excess capacity or limit it. Reforms to reduce the effort and mobility of large-scale harvesters could provide benefits to SIDs and LDCs and small-scale fisher communities in those countries, by allowing them access to resources no longer taken by distant-water fleets.

One important insight from the literature is that some of the linkages are not unambiguously positive or negative; rather, they depend on the circumstances and vary according to location and scale, and the impacts of actions taken in relation to one target may differ across stakeholders. For example, the way coastal and marine ecosystems are managed impacts fish stocks, and the impact will differ across fisheries and locations. Similarly, fishery subsidies may impact access to resources of small-scale fishers in different ways depending on how they are designed. They can also impact economic benefits for SIDS and LDCs.

In summary, the set of targets that were included under SDG 14 cover a wide range of issues, which exhibit close interrelationships. The majority of action-type targets can have negative or positive impacts on the "recipients" of the action, and the majority of outcome-type targets can be affected positively or negatively by many policies or measures, in all cases depending on the thought and care put into the design of the measure, and the effort put into its implementation and follow-up. Adaptive management, which includes regular monitoring of the ecological, social and economic impacts of the management action, is important for ensuring that management achieves its objectives and avoids unintended negative consequences.

4 Links between individual targets of SDG 14 and other SDGs

4.1. Reduce marine pollution

Target 14.1 calls for prevention and significant reduction of marine pollution by 2025. Reduction in marine pollution protects coastal and marine ecosystems, and contributes to food security (SDG 2) and improving human health and well-being (SDG 3). It also contributes to decent work and economic growth (SDG 8) because employment in sectors such as tourism is directly dependent on clean, unpolluted seas. Reducing pollution also has the potential to contribute to climate change adaptation (SDG 13) because removing other stressors, in particular pollution and overfishing, is likely to increase the resilience of marine ecosystems, such as coral reefs, to the impacts of climate change (Hughes et al, 2003). Action in six other SDGs (6, 8, 9, 11, 12 and 15) has a direct and positive impact on that effort; mainly through the reduction of waste and litter produced by land-based activities that reaches oceans. These interlinkages are illustrated in Table 1.

Pollution negatively affects human health through direct contact with pollutants or through eating fish and other marine products contaminated by heavy metals, long-lived and harmful chemicals and materials, persistent organic pollutants and other toxins that accumulate in the food chain (UN, 2016b; Millennium Ecosystem Assessment, 2005; UNEP, 2006, 2012b; IIASA, 2012). Reduction of marine pollution contributes to the achievement of SDG 3 by reducing the number of deaths and illness from water pollution and contamination (SDG target 3.9). Microbial contamination related directly and indirectly to human and

animal activity is increasingly affecting the safety of the seafood supply, as well as the commercial and recreational use of coastal marine waters. In addition to microbial contamination, predominantly anthropogenic chemical contamination of marine waters has led to high levels of heavy metals, polyaromatic hydrocarbons, and other environmentally persistent substances entering the marine food chain (Fleming et al., 2006).

Increased nutrient loading from human activities, combined with the impacts of climate change and other environmental change has resulted in an increase in the frequency, magnitude, and duration of harmful algal blooms (HABs) worldwide. HABs can contaminate seafood with toxins, and impact ecosystem structure and function, recreational activities, fisheries, tourism and coastal property values (e.g. Gilbert et al., 2014 and Watson and Molot 2013), thus adversely impacting achievements of SDGs 2, 3 and 8. Nutrient over-enrichment from agricultural, municipal and industrial sources is also considered to be the main cause of so-called "dead zones", hypoxic regions that exhibit oxygen levels that are too low to support many aquatic organisms including commercially desirable species (adversely impacting SDG 2 and target 14.3), the extent and duration of which is also increasing worldwide (Rabotyagov et al., 2014).

Population in poor coastal communities are particularly at risk of suffering from health problems caused by nearshore marine pollution, both directly through consumption of food as well as indirectly through the degradation of marine resources that sustain their livelihoods (Millennium Ecosystem Assessment, 2005; Ramsar and UNWTO, 2012). In addition, pollution also reduces people's enjoyments of marine goods and services to fulfill physical, material, cultural and spiritual needs.

Marine-based activities such as solid and liquid waste from sailing, shipping and cruising activities (ECLAC, 2012), accidental loss or intentional discarding of fishing gear (FAO, 2016, OECD, 2012), hazard material resulting from ship recycling (IMO, 2012), discharge of wastes from aquaculture into marine ecosystems (World Bank, 2010), among others, pollute and degrade coastal areas and open oceans (UNEP, 2012a).

However, more than the pollution generated at sea, a critical cause of marine pollution is from litter and waste originated from domestic, agricultural, commercial and industrial land-based activities (UN, 2016b). The reason is that a large share of population and productive activities are located in coastal areas or close to river catchments, and those activities release waste and pollutants into water that discharge in streams and coastal zones (UNEP, 2012a; IOC/UNESCO et al., 2011). Therefore, economic growth and urbanization are some of the drivers of marine pollution, and progress in the implementation of SDG 14 could be expected as the result of implementation of other SDG targets that aim at reducing and treating waste.

For example, access to sanitation (SDG 6) remains a challenge in many coastal cities and limited wastewater infrastructure result in sewage entering coastal areas untreated (UNEP, 2010; Millennium Ecosystem Assessment, 2005). Increasing urbanization of coastal areas (SDG 11) unaccompanied by adequate disposal of human bodily wastes, has imposed major pressures on the ocean (United Nations, 2016b; UNEP, 2010). That problem is particularly severe in resort areas, including in many small island developing states that lack appropriate sewage treatment facilities (Millennium Ecosystem Assessment, 2005; Ramsar and UNWTO, 2012; ECLAC, 2012). Wastewater originated from industry and agriculture also pollutes marine ecosystems through the discharge of hazard chemicals, pesticides and fertilizers into streams and oceans (UN, 2016b).

Marine pollution is also caused by production and consumer practices (SDG 12) that do not consider life-cycle impacts of products and the effect of marine litter (UNDESA et al., 2014). The majority (~80%) of marine litter, also known as marine debris, originates from land-based sources, the remaining 20% comes from sea-based sources such as maritime

Table 1
Important links of target 14.1 with the rest of the SDGs

SDG	From	To	Description of link	Geographic level
SDG 2 Food security		X	Pollution of marine and coastal areas makes seafood improper for human consumption	Local National
SDG 2 Food security	X		Efforts to increase food production on land or aquaculture may increase pollution of coastal areas	Local National
SDG 3 Health and well-being		X	Pollution of coastal areas negatively impacts health and well-being	Local National*
SDG 6 Water	X		Wastewater (industrial and residential) and agricultural runoff cause pollution of sea.	Local National*
	X		Wetlands protect water quality by trapping sediments and retaining excess nutrients and other pollutants such as heavy metals that may otherwise end up in the sea.	National
SDG 8 Economic growth and employment	X		Economic activities (e.g. agriculture, transport, tourism, minerals extraction, aquaculture) generate ocean pollution	Local National*
SDG 9 Industrialization and infrastructure	X		Industrial by-products and waste (e.g. heavy metals, chemicals, particulate matters) pollute oceans. On the other hand, efforts to improve the quality of infrastructure and planning for industrialization could have large positive impact on coastal areas currently detrimentally impacted by industry.	Local National*
SDG 11 Cities	X		Pollution from urban activities (solid and liquid) causes pollution in oceans.	Local National*
SDG 12 Sustainable consumption and production	X		Pollution can be reduced through reduced waste generation, and cleaner production methods	National Regional Global
SDG 13 Climate change		X	Pollution acts with other stressors to hamper the resilience of ecosystems to climate change	Local National
SDG 15 Terrestrial ecosystems	X		Management of terrestrial ecosystems may increase or reduce pollution loads to oceans	Local National*
SDG 16 Peaceful and inclusive societies	X		Effective institutions in general help achieve effective control of and reduction in pollution	National Regional Global

Source: Authors' elaboration.
* Indicates potential for transboundary effects.

transport, fishing and industrial exploration. The impacts of marine debris include entanglement of and ingestion by marine animals, and it has been identified as a global problem (United Nations 2016b). Another life-cycle related impact of products comes from the lack of upgrading and maintenance of ageing infrastructure (SDG 9) such as oil pipelines (CBD, 2014).

Some of the policy messages relevant to reducing marine pollution caused by solid waste, wastewater, and marine litter include: ensuring access to basic sanitation to coastal communities (FAO, 2014b), raising public awareness and encouraging change of attitude and behavior related to solid waste management (UNDESA et al., 2014); life-cycle planning and accountability; incorporating knowledge of coastal

processes and applying best wastewater management practices into urban planning, integrated watershed and coastal management, and infrastructure development (UNEP and WCMC, 2006); systematic reporting to identify hotspots for priority treatment (UNEP, 2010); practical guidelines on waste management and tourism development (UNDESA et al., 2014); and changing policies and incentives to recognize wastewater as a potential resource with real economic value (UNEP, 2010).

4.2. Sustainably manage and protect marine and coastal ecosystems

Target 14.2 calls for sustainable management and protection of marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and to take action for their restoration in order to achieve healthy and productive oceans.

Marine and coastal ecosystems include coral reefs (both tropical and cold water), mangroves, wetlands, rocky intertidal, nearshore mudflats, deltas, beaches, and dunes, seagrasses, coastal shelf ecosystems, deep water ecosystems (such as seamounts, hydrothermal vents, abyssal plains and canyons), and open ocean pelagic ecosystems . They provide ecosystem services and products such as food, water, medicine, construction materials, energy, transport, shoreline stabilization, coastline protection and erosion prevention, climate regulation, maintenance of biodiversity, recreation, aesthetic and spiritual values as well as an important basis of livelihoods for many coastal communities (Millennium Ecosystem Assessment, 2005; World Bank, 2010; UNEP, 2006, 2010, 2012, 2014; UNEP, IOC, UNESCO, 2009; Ramsar and UNWTO, 2012; ESCAP, 2016; CBD, 2014). All these marine ecosystem services have substantial economic value. While there is much debate about valuation methods, studies have found these values to be on the order of trillions of US dollars annually (Costanza, et al., 1997 and United Nations 2016b). Worldwide, the ocean enables approximately 350 million direct and indirect jobs in several sectors including fishing, shipping, tourism, biotechnology, energy, and other sectors (World Bank, 2013; UNEP, 2006; UNCTAD, 2014).

No area of the ocean is unaffected by human influence and a large fraction (41% in 2008) is strongly affected by multiple drivers. However, large areas of relatively little human impact remain, particularly near the poles (Halpern et al, 2008). Major adverse impacts to ecosystems from unsustainable resource exploitation, destruction of habitats and pollution act cumulatively with global impacts from ocean acidification, ocean warming, shifting currents, reduced mixing and decreasing oxygen levels. The impacts of all these threats are already apparent and expected to increase (Noone, Sumaila and Diaz, 2013; United Nations, 2016b). The need to understand the interactions and potentially cumulative or multiplicative effects of multiple stressors has been identified as one of the most important questions in marine ecology today (Darling and Côté, 2008).

Human population is projected to increase to more than 9 billion people by 2050, bringing increasing pressure on environmental resources. With coastal ecosystems supporting a large fraction of the human population, it is likely that coastal ecosystems in populated areas are going to be greatly altered from their undisturbed state.

Efforts to increase food security globally are likely to require increasing food taken from the ocean (capture fisheries and aquaculture), putting further pressure on both marine resources and ecosystems, and challenging conservation and livelihoods strategies to find common solutions (Rice and Garcia, 2011). Thus the relationship between target 14.2, SDG 1 on poverty reduction and SDG 2 on food security and hunger will likely involve trade-offs.

Marine and coastal areas are vulnerable to climate change impacts, including ocean warming, de-oxygenation and sea level rise. The latter could lead to coastal erosion and flooding, saltwater intrusion, low drinking water availability, and may cause loss of habitat and people's livelihood (IAASTD, 2009; IOC/UNESCO et al., 2011, ECLAC, 2011). At the same time, oceans have a role to play in both climate

Table 2
Important links of target 14.2 with the rest of the SDGs

SDG	From	To	Description of link	Geographic level
SDG 1 Poverty		X	Management of coastal ecosystems impacts the resilience of local communities (e.g. mangroves for flood protection)	National Regional Global
		X	Management of coastal ecosystems impacts local poverty and livelihoods (e.g. through access provisions)	Local
	X		Addressing poverty may reduce local pressures to manage ecosystems unsustainably. At the same time, the number of poor people in coastal areas is likely to increase greatly in the coming decades, putting further pressure on ocean and coastal resources	Local
SDG 2 Food security	X		Efforts to increase food security will likely require increasing food taken from the ocean. This implies significant alteration of coastal ecosystems	National Regional Global
SDG 4 Education	X		Education provides tools for ecosystems managers and material for capacity-building in ecosystems management	National Regional Global
SDG 7 Energy	X		Marine renewable energy disturbs ecosystems, competes for space with other ecosystem users (e.g. tidal, marine currents, offshore wind)	Local
SDG9 Infrastructure and industrialization	X		Infrastructure disturbs management of coastal (tourism, ports) and marine (e.g. offshore oil and gas extraction, offshore wind) ecosystems. On the other hand, efforts to improve the quality of infrastructure and planning for industrialization could have large positive impact on coastal areas currently detrimentally impacted by industry	Local National
SDG 11 Cities	X		Pollution from urban activities (solid and liquid) causes pollution in oceans. Increasing urban densities along coasts increase the pressure on coastal areas	Local National
SDG 13 Climate change	X		Climate change results in sea temperature increase, change in oxygen content, changes in marine currents, which affect the management of marine ecosystems	National Regional Global
		X	Oceans act as a climate regulator, absorb heat and CO_2	Global
SDG 15 Terrestrial ecosystems		X	The status of coastal and marine ecosystems impacts terrestrial ecosystems through provision of habitat and food for terrestrial fauna.	Local National Regional
	X		Management of terrestrial ecosystems may impact coastal areas through e.g. displacement of people or economic activities	National
SDG 16 Peaceful and inclusive societies	X		Effective institutions in general help achieve sustainable management of marine and coastal ecosystems	National Regional Global

Source: Authors' elaboration.

change adaptation and mitigation. Costs of climate change adaptation could be expected to increase with the reduction of the natural resilience of coastal areas (ECLAC, 2011). Marine conservation and sustainable management, including through marine protected areas and effective fisheries management, is likely to increase the resilience of marine ecosystems to the impacts of climate change (Jackson et al., 2014). These actions may by extension build the resilience of the coastal poor and those in vulnerable situations, and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters, thus contributing to SDG 1 on poverty.

Clean energy (SDG 7) is one component of a blue economy, which can help SIDS and LDCs reduce their dependence on fossil fuels and benefit from their marine resources, thus helping achieve target 14.7. However, actions taken to mitigate climate change may involve trade-offs with other ocean-related objectives, and care needs to be taken to ensure that in the process the achievement of target 14.2 is not compromised. Chapter 7 of IPCC AR 5 WG III highlights that the ocean will have a role in many of the promising avenues for mitigation of climate change. Windfarms in shallow coastal areas, tidal and wave power are promising technologies for non-carbon-based energy production in the coming decades. However, these will increase pressure on coastal marine systems, with negative local impacts on many ecosystem features, including resilience. While the long-term benefits of reducing GHG emissions may justify the pressure, such pathways are likely to act antagonistically, not synergistically with some dimensions of SDG 14.

Reducing impacts on marine ecosystems is also dependent on achieving SDG 15 on terrestrial ecosystems. Because individual stressors interact, managing each activity that impacts marine ecosystems in isolation will be insufficient to achieve ocean health and resilience. Multiple stressors call for integrated management in the context of an ecosystem approach (Halpern et al., 2008; Darling and Côté, 2008, UN, 2002, UNEP, 2010, World Bank, 2010; IIASA, 2012).

All human activities impacting the marine environment take place in an integrated socio-ecological system. Thus institutions and governance will need to incorporate the simultaneous consideration of several uses or industries and the livelihoods and other social aspects connected with this ensemble of activities (see Box 2). Ecosystem approaches enable the consideration of tradeoffs among different uses and beneficiaries, enlarging the range of policy options.

Box 2
Importance of institutions for managing ecosystems sustainably

A recent study found that areas where coral reef ecosystems were in substantially better health than expected ("bright spots") were characterized by strong sociocultural institutions such as customary taboos and marine tenure, and high levels of local engagement in management. The paper recommended that investments that strengthen fisheries governance, particularly issues such as participation and property rights, could help communities to innovate in ways that allow them to defy expectations. Additionally, governance structures that foster flexible learning and experimentation and renewed focus on managing the socioeconomic drivers that shape reef conditions were important conditions for success.

Source: Cinner, 2016.

Capacity and technologies to manage human impacts on the marine environment in an integrated manner are still lacking, and capacity building for SIDS and developing countries is an important component of this target. It is also important that decision-makers, managers, and other actors fully understand the effects of their activities on marine and coastal ecosystems. In that regard, education, communication, public awareness and community empowerment, are critical components of successful ecosystem management (UNEP, 2006).

Table 3
Important links of target 14.3 with the rest of the SDGs

SDG	From	To	Description of link	Geographic level
SDG 8 Economic growth	X		Economic activity and transport emit greenhouse gases, which cause acidification	Local Regional Global
SDG 2 Food Security		X	Failing to reduce ocean acidification would have negative impacts on food security	Global
SDG 4 Quality education	X		Improved opportunities for scientific education and research will better enable developing country scientists to participate in ocean acidification networks.	Global Regional
SDG9 Infrastructure and industrialization	X		Industries emit greenhouse gases, which cause acidification	Local
SDG 11 Cities	X		Cities and their activities emit greenhouse gases, which cause acidification	Local National Regional
SDG 13 Climate change	X		Action to limit CO_2 emissions would help limit ocean acidification	National Global

Source: Authors' elaboration.

4.3 Ocean acidification

Target 14.3 aims to minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels. Ocean acidification has increased by approximately 26% since pre-industrial times as a result of increased releases of CO_2 due to the burning of fossil fuels and other human activities. The saturation state of carbonate in seawater varies by depth and region, and is typically lower in polar and deep waters due to lower temperatures, making polar areas more vulnerable to the combined impacts of warming and acidification. Similarly, deep and cold water biodiversity, such as cold water coral reefs, are particularly vulnerable to acidification. Because cold water corals provide important habitat for fish, acidification will negatively impact fisheries, and thus target 14.4 and SDG 2. When carbonate becomes undersaturated, calcium carbonate, which many organisms use to form shells and skeletons, will dissolve if unprotected. The combination of ocean acidification, increases in upper-ocean temperature, stratification and de-oxygenation of sub-surface waters can lead to significant changes in organism physiology and habitat range in the ocean (Secretariat of the Convention on Biological Diversity, 2014, 2016). Thus there is a clear and direct link between SDG target 14.3 and Goal 13 in regards to causation and response measures (emissions reductions, protection of marine ecosystems from additional stressors, and other potential adaptation measures), and they are best addressed together.

Enhanced scientific cooperation on all levels has been identified as critical to achieving target 14.3. Some potential response measures include effective monitoring of ocean acidification across a range of spatial and temporal scales, which is crucial to better understand current variability. In addition, modelling how acidification and its impacts will change over the coming century is important for designing policy responses. The recently established Global Ocean Acidification Observing Network (GOA-ON) is a major scientific collaboration towards this end, and is supported by the Global Ocean Observing System (GOOS), the IAEA Ocean Acidification International Coordination Centre (OA-ICC),

IOC-UNESCO, and the International Ocean Carbon Coordination Project (IOCCP) (Secretariat of the Convention on Biological Diversity, 2014, 2016). Because of the need for more scientific research, there is a strong linkage to SDG Target 14.a and SDG 4 on education, which includes the need to involve developing country and SIDS scientists in these networks. In addition, there is some evidence that priority areas for protection should include areas that may be most resilient to the impacts of climate change, and thus act as refuges of important biodiversity. This would imply that climate change be taken into account in decisions related to design and management of marine protected areas, and in broader applications of the ecosystem approach, such as in marine spatial planning (Jackson at al., 2014) and would link this target to targets 14.2 and 14.5. Other policy recommendations, particularly focusing on deep water corals, include (i) minimizing impact of other anthropogenic stressors on the system, (ii) maximizing the likelihood of survival of the species and its associated biota at other sites globally; and (iii) identifying and protecting future refugia internationally (Thresher et al., 2015). These actions seek to increase the adaptive capacity of the system as a whole.

4.4 Restore fish stocks

The sustainable use of oceans entails harvesting and fishing practices that are both economically viable and maintain a healthy level of fish stock (World Bank and FAO, 2009). Target 14.4 calls for effective regulation of those practices and the implementation of science-based management plans to restore fish stocks at least to biologically sustainable levels.

The prevention of the depletion of fish stock contributes to food security at global and local levels (SDG 2) (ESCAP, 2016). Overfishing remains a cause of concern. The practice reduces fish stocks and could damage marine habitats also affecting non-target species (CBD, 2014). Some recent meta-analyses have concluded that the extent of overfishing was most widespread and intense some 15 years ago (+/- 5 years). There are parts of the world where overfishing continues to increase, but in other parts of the world where sufficient resources were invested in science, assessment, management, control and surveillance, the corner was turned before the end of the 2000 (Hilborn 2011; Hilborn and Stokes, 2010; FAO, 2016). Other studies have concluded that overfishing has not improved (Froese et al.,2016).

The interrelationships of target 14.4 with other SDG targets are complex. Fisheries have strong connections to livelihoods and poverty, employment, food security and nutrition, and industry. Their impacts are felt both at the community level and at the macro-economic level. They are affected by climate change and its effects. As providers of a key component of food diets, they are directly affected by changes in the demand for food stemming from higher incomes and changing consumption patterns. There is therefore a strong link with SDG 12 (sustainable consumption and production). The need to take this multi-dimensionality into account for policy and evaluation purposes is reflected in attempts to devise comprehensive sets of indicators for fisheries (see e.g. Anderson et al., 2015).

Fisheries reform to increase their sustainability could reduce the negative impact of that sector on the marine environment and increase its contribution to economic growth and job creation in many countries (World Bank and FAO, 2009). At the same time, as shown by a study by FAO, some of the places where overfishing is most severe and has proven least tractable to reverse are coastal areas of less developed countries, where migration of people to coastal areas has swelled the population of artisanal fishers. In such areas, achieving sustainable levels of exploitation is going to require a reduction in participation in small-scale coastal fisheries (FAO, 2016).

Combined fisheries and conservation objectives can be achieved by merging diverse management actions, including catch restrictions, gear modification, and closed areas, depending on local context. Impacts of international fleets and the lack of alternatives to fishing complicate prospects for rebuilding fisheries in many poorer regions, highlighting the need for a global perspective on rebuilding marine resources (Worm et al, 2009). Implementation and

Table 4
Important links of target 14.4 with the rest of the SDGs

SDG	From	To	Description of link	Geographic level
SDG 1 Poverty		X	Healthy fish stocks generate livelihoods for local communities	Local National
	X		Addressing poverty and providing alternative livelihoods may reduce local pressures on fish stocks and create incentives for sustainable management of local fisheries	Local
SDG 2 Food security and agriculture		X	Fisheries contribute to local and global food security	Local National Global
	X		Demand for fish for food and feed causes pressure on fish stocks	National Global
SDG3 Health		X	Increasing fish in human diets benefit both developed world consumers and developing countries – with needed protein and micronutrients	Local National
SDG 8 Economic growth and employment	X		Growth in incomes increases the global demand for fish	National Global
		X	Well-managed fisheries could increase the contribution of that sector to economic growth and job creation. At the same time, reduction of participation in fisheries may be needed in places currently witnessing overfishing	National
SDG 12 Sustainable consumption and production	X		Changes in consumption behaviors impact the demand for food and may increase or decrease pressure on fish stocks	National Regional Global
	X		More efficient fishing methods and regulation (e.g. reducing discards, by-catch, less destructive fishing methods) benefit fish stocks	National Regional Global
	X		Sustainability standards and certification for fisheries can contribute to more sustainable management of fisheries	Global
SDG 13 Climate change	X		Climate change results in sea temperature increase, change in oxygen content, changes in marine currents, which impact fish stock, including the geographic range of species. Effects could be positive or negative	National Regional Global
SDG 16 Peaceful and inclusive societies	X		Effective institutions in general help achieve effective institutions for managing fish stocks	National Regional Global
SDG 17	X		Trade rules and trade-related policies impact fishing	Global

Source: Authors' elaboration.

enforcement of science-based catch or effort limits is also key to successful fisheries management (Melnychuk et al, 2017).

In addition to effective regulation of harvesting and fishing practices, prospects for increasing the level of fish stock are affected by broader social and economic processes associated with economic growth and poverty reduction, mainly through the resulting changes in food consumption patterns (OECD, 2012). An example is the shifts of consumer preferences in emerging economies such as China toward high-value fish, driven by increases in income per capita combined with demographic change and urbanization (World Bank, 2013b).

Fish stocks are also at risk of impact from climate change such as ocean acidification, increase in sea temperature, decrease in oxygen content and change in marine currents, which affect marine ecosystems (ESCAP, 2016).

4.5 Conserve 10 percent of coastal and marine areas

Target 14.5 calls for the conservation of at least 10 per cent of coastal and marine areas by 2020. This target is a reflection of Aichi Biodiversity Target 11, as well as earlier international commitments.

The main purpose of conservation measures is to rebuild and protect coastal and marine areas and resources; but they can also support economically valuable activities and have important social impacts (UNDESA et al., 2014). Area-based conservation measures and management tools can be used to help achieve target 14.5, including through the application of an ecosystem approach using tools such as marine spatial planning, integrated coastal zone management and the establishment of marine protected areas (MPAs). Area-based measures undertaken as part of fisheries management, such as the identification and closure of Vulnerable Marine Ecosystems (VMEs) can also be used to help achieve this target. In addition, many community-based measures, including customary marine managed areas, have been effective in achieving outcomes for both conservation and livelihoods (Govan et al., 2009; Jupiter et al., 2014).

MPAs are a commonly-used tool for conserving biodiversity, and their establishment has been driven by a range of international, regional and national obligations. The rate of MPA establishment has increased in recent years, with a global coverage of around 3.4% (12.3 million km^2) measured in 2014, with most MPAs occurring in territorial seas and very few in areas beyond national jurisdiction (Boonzaier and Pauly, 2016). There has been a recent trend in the establishment of large remote MPAs that has further increased global coverage, but according to some has come at the expense of smaller MPAs in heavily used seas, raising questions about whether this trend will lead to a global network that is effective, representative, connected and equitably managed (Jones and De Santo, 2016). Many different types of MPAs exist, ranging from those that prohibit extractive activities to those that allow specific sustainable uses. MPAs can accomplish a broad range of objectives from habitat and species protection, fisheries outcomes, sustainable uses, cultural objectives, public education and outreach, and application of the precautionary and ecosystem approaches.

The environmental benefits accrued from MPAs depend on the design and management of the area. MPAs often fail to reach their full ecological potential as a consequence of factors such as illegal harvesting, regulations that legally allow detrimental harvesting, or emigration of animals outside boundaries because of continuous habitat or inadequate size of reserve.

The socio-economic benefits created by MPAs remain difficult to predict and are under debate. Impacts (positive and negative) can vary within and among social groups (Mascia et al., 2010). MPAs close to the coast can either help or hurt local people and communities. Coastal communities adjacent to the MPA, especially those with a high economic dependence on the fishery, may face a disproportionate impact as a result of reduction in catch and fishing revenue. These costs occur in the short term. The

potential benefits, including increased total catches or larger-sized fish catches due to spillover effects may take a long time to materialize. MPA establishment may also result in shifts in resource access and use, with those gaining preferential resource access experiencing increased income and food security, and those losing access suffering corresponding losses (FAO, 2011).

Well-managed MPAs can improve local livelihoods and benefit local communities, leading to empowerment, improved governance, alternative livelihoods, improved fisheries, and social, educational, and cultural benefits (Salm and Siirila, 2000; Sobel and Dahlgren, 2004, FAO, 2011). They can provide tourism jobs, improve fisheries landings and resilience (Agardy, 1993; IUCN 2008; Cohen et al., 2008), thus providing a link with SDGs 1 and 8. However, the linkages between MPAs and poverty reduction are often complex and not well understood. Some MPAs have been criticised of being "biological successes and social failures" through limiting participation, inequitably sharing economic benefits, and lacking in conflict resolution mechanisms (Christie, 2004), and there are cases where MPAs have restricted local livelihoods (Brondo and Woods, 2007), have exacerbated pre-existing conflict (Bavinck and Vivekanandan, 2011), and have lost support as control is transferred from local community to central government (Hind, Hiponia and Gray, 2010).

The realization of MPA benefits, whether ecological or socio-economic, depends on the local context and how they are designed and implemented (FAO, 2011). Community-based management and co-management approaches, which include a high degree of transparency, inclusion and participation, while sharing benefits of conservation locally, have been found to be particularly effective in empowering communities to manage their own resources (Bennett and Deardren, 201; Govan et al., 2009; Jupiter et al., 2011). However, achieving both conservation and poverty-reduction outcomes through MPAs is difficult, as the MPAs that are most effective in producing conservation outcomes may have different requirements from those that are most effective for poverty reduction and coastal livelihoods outcomes. This is particularly true in the face of climate change, and a dialogue between policy-makers and science advisors working on biodiversity conservation and human livelihoods issues is required to provide a better understanding of trade-offs and to generate compatible policies and management actions (Rice and Garcia, 2011). More management effectiveness assessments, plus a greater focus on measuring biodiversity and social outcomes, are needed (Juffe-Bignoli et al., 2014). Management effectiveness in turn requires effective institutions, providing a link to SDG 16 as well as a consideration of local livelihoods.

Some lessons may be learned from the success of local and traditional approaches in many areas. For example, the Pacific has seen a proliferation of Marine Managed Areas (MMAs) in the last decade. These protected areas, implemented by over 500 communities spanning 15 independent countries and territories, covered over 12,000 km^2 of ocean space in 2009. MMAs are built on a unique feature of the region, customary tenure and resource access, and make use of, in most cases, existing community strengths in traditional knowledge and governance, combined with a local awareness of the need for action. Such customary marine managed areas have the potential to achieve outcomes benefiting both communities and coastal resources (Govan et al, 2009; Jupiter et al, 2011). Additional area-based management strategies that have the potential to contribute to both conservation and use outcomes, if well designed and implemented, include marine spatial planning and zoning, which can lead to reduction of conflicts, as well as the integration of MPAs with the overall management framework, including fisheries management (Rice and Garcia, 2011; Douvere, 2008).

The above studies confirm the importance of considering community livelihoods when putting in place marine conservation measures, particularly when "no-take" MPAs are established, including through providing for alternatively livelihoods. Governance could be improved through increased transparency, accountability, participation, coordination, legitimacy and adaptability, while fairness or equity could be

Table 5
Important links of target 14.5 with the rest of the SDGs

SDG	From	To	Description of link	Geographic level
SDG 1 Poverty		X	Protection of coastal and marine areas may impact the livelihoods and resilience of local communities	Local National
SDG 2 Food Security		X	Increasing protected areas could have positive and negative impacts on food security, depending on the place, scale and time horizons that are considered	Local Regional Global
SDG 4 Education	X		Education may increase public demand and support for conservation	National
SDG 8 Economic growth and employment		X	Protection of coastal areas may affect employment locally and economic growth, with impacts differeing across occupations and sectors	Local National
SDG 10 Inequality		X	Protection of coastal areas may affect inequality locally through changing access to resources	Local
SDG 13 Climate change	X		Lack of climate change mitigation makes effective protection of ecosystems more difficult, through a variety of effects	National Regional Global
SDG 15 Terrestrial ecosystems		X	Protection of coastal areas benefits terrestrial ecosystems	Local National
SDG 16 Peaceful and inclusive societies	X		Effective institutions are important for achieving conservation and management of marine areas, including through marine protected areas. This applies to local and national-level institutions, as well as global and regional institutions relating to implementation of international law as reflected in UNCLOS	Local National Regional Global

Source: Authors' elaboration.

increased through creating means to share benefits of conservation locally, particularly by supporting local economic and tourism development, capacity building programs, and hiring practices (Bennett and Deardren, 2014). Thus, while linkages to SDG 1 exist, they would need to be considered together with SDGs 8, 10 and 16.

4.6 Fisheries subsidies

SDG target 14.6 calls for the prohibition by 2020 of fisheries subsidies that contribute to overcapacity and overfishing, illegal, unreported, and unregulated fishing. Existing subsidies cover multiple objectives and have multiple effects that vary depending on their design; in many cases, their impacts have not been documented or are uncertain (Sumaila et al., 2010). Some aspects of fishery subsidies have been abundantly discussed. In some cases, they create incentives that lead to unsustainable practices and overfishing (World Bank and FAO, 2009; OECD, 2012; IAASTD, 2009). Fishery subsidies may also divert resources that could have been invested in other productive sectors or basic services such as education and health (World Bank and FAO, 2009). In some cases, however, subsidies can also contribute to reducing overfishing, for example by financing license buy-backs or seasonal tie-up for limiting effort on water. Thus fisheries subsidies can help achieve management objectives if used to limit fishing pressure rather than enhance fishing capacity (Melnychuk et al, 2016).

Fishery subsidies have a number of policy-relevant connections with other targets under SDG 14. It has been documented that fishery subsidies tend to favor large-scale industrial fishers versus small-scale fishers, thus affecting target 14.b (Jacquet and Pauly, 2008). They may also have an adverse impact on target 14.5, as interest groups in favor of subsidies may be opposed to increased marine protection efforts. Subsidies also have linkages with other SDGs, as documented in Table 6 below. For example, through lowering the price of fish, they may discourage efforts to change consumption patterns aiming at ensuring the sustainability of fisheries (SDG 12). Yet, one of the reasons for their existence is to sustain jobs, and by extension to reduce poverty. The World Trade Organization (WTO) is engaging in discussions over achieving outcomes on fisheries subsidies relevant to SDG 14.6, thus also adding a linkage to trade (SDG 17).

4.7 Increase economic benefits for SIDS and LDCs

Target 14.7 calls for the increase of economic benefits to SIDS and LDCs, by 2030, from the sustainable use of marine resources. The target emphasizes the importance of the sustainable management of fisheries, aquaculture and tourism.

SIDS face particular sustainable development challenges, including small populations, limited resources, vulnerability to natural disasters and external shocks, high dependence on foreign imports, and little or no opportunity to create economies of scale. LDCs often share many of the SIDS challenges. Ocean-based activities are particularly important for SIDS (ECLAC 2011a, 2013a). The sustainable development of SIDS and the oceans agenda are intertwined. Many SIDS have maritime zones, which are disproportionately larger than their land territory. Fisheries and tourism are currently the predominant

Table 6
Important links of target 14.6 with the rest of the SDGs

SDG	From	To	Description of link	Geographic level
SDG 1 Poverty		X	Depending on how they are designed, fishery subsidies may contribute to sustaining livelihoods in the fishing industry	Local National
SDG 2 Food security		X	Changes in subsidies may impact food security through changes in prices of fish	
SDG 4 Education	X		Education provides tools for managers and increases capacity to design and manage subsidies	National
SDG 8 Economic growth and employment		X	Depending on how they are designed, fishery subsidies may contribute to sustaining jobs in the fishing industry and support downstream activities	Local
SDG 10 Equality		X	Implementation or removal of subsidies affect income inequality	Local National
SDG 12 Sustainable consumption and production		X	Fisheries subsidies that encourage overfishing may reduce the incentives for sustainable consumption and production, e.g. through keeping fish price lower than its true social cost	National Global
SDG 16 Peaceful and inclusive societies	X		Effective institutions in general can help achieve international outcomes in relation to fisheries subsidies.	National Regional Global
SDG 17	X		Trade rules and trade-related policies impact this target, in particular ongoing WTO discussions.	Global

Source: Authors' elaboration.

ocean-dependent industries in SIDS and coastal LDCs, and maritime shipping is their lifeline to global markets. For example, tourism contributes, directly and indirectly, to over 30% of jobs in the Jamaica (ECLAC, 2011b). Fisheries are similarly extremely important for many SIDS. In the Pacific, tuna vessels employ about 10,000 Pacific Islanders and 21,000-31,000 people are engaged directly and indirectly in tuna-related employment (UNDESA et al., 2014). Many SIDS also benefit from the sale of offshore fishery licenses.

The long-term sustainability of fisheries in SIDS has been threatened by overexploitation of living marine resources, land-based pollution, and inadequate fisheries monitoring, control and surveillance systems. Implementation of regulations and management frameworks to address overfishing is a particular challenge for SIDS and LDCs, in some cases, due to lack of capacity. In spite of these challenges, fisheries management and the economic value derived from fisheries for SIDS have been improving through a number of measures. However, sometimes these economic activities have limitations in terms of potential for increasing incomes and job creation, and in many SIDS and LDCs there is the pressing need for economic diversification. For example, when tourism is developed as an enclave activity with few or no linkages with the local economy, its impact on job creation and on increasing income of the average household is negligible. On the other hand, when tourism increases demand for local products and services, it could have strong employment effects, for example in areas such as the provision of local food or local cultural goods, such as music, arts and crafts (UNCTAD, 2013; UNEP and UNWTO, 2012).

Economic benefits from the oceans for SIDS and many of the LDCs can be framed in terms of sustainable "blue growth" or "blue economy", a concept aimed at reconciling ocean-related economic growth with improved livelihoods and social equity, and strengthening transparent, reliable and more secure food systems based on sustainable use of resources. The concept of a "blue economy" emphasizes conservation and sustainable management, based on the premise that healthy ocean ecosystems are more productive and form a vital basis for sustainable ocean-based economies. The blue economy moves beyond business as usual to consider economic development and ocean health as compatible propositions (UNCTAD, 2014, UNEP, 2015b, FAO, 2014b), and provides strong linkages between this target and almost all other SDG 14 targets, as well as to most other SDGs, in particular to those related to reducing poverty and hunger (SDGs 1 and 2), improving health and well-being (SDG 3), decent work and economic growth (SDDG 8), and industry and innovation (SDG 9).

While stimulating growth in oceans-related sectors is comparatively straightforward, it is not always clear what a sustainable ocean economy should look like, and under what conditions it is most likely to develop. For each country, the formula is likely to be different, depending on unique national circumstance, its maritime zones, existing economic activities and the degree to which they can be expanded without harm to the environment, the potential for new and innovative activities, as well as issues related to capacities and unique environmental, social and cultural conditions (FAO, 2014b, UNEP, 2015b). The blue economy can consist of diverse components, including established ocean industries such as fisheries and tourism, and emerging and new activities—such as offshore renewable energy, aquaculture, marine biotechnology and (where sustainable) deep seabed mining. Larger industries such as coastal development, shipping and port infrastructure and services are also reliant on the oceans, seas and the coasts as a setting for economic activities. Marine renewable energy sources have been identified as priority areas for SIDS, providing a linkage to SDG 7 on affordable clean energy. Seabed exploration and exploitation of minerals and other resources has been of particular interest to Pacific SIDS. Marine biotechnology can provide an option for SIDS and coastal LDCs to grow their economies, but has not yet been explored beyond a few scientific collaborations with developing country universities and companies.

Table 7
Important links of target 14.7 with the rest of the SDGs

SDG	From	To	Description of link	Geographic level
SDG 1 Poverty		X	Increased economic benefits for SIDS and LDCs can contribute to decreasing poverty	Local National
SDG 2 Food security		X	Improved management of fisheries and new aquaculture ventures, undertaken as part of a transition to a blue economy, can help reduce hunger. However, care needs to be taken to implement aquaculture in an environmentally sustainable manner to reduce potential negative impacts on ecosystems	National
SDG 4 Education	X		Economic diversification requires a well-trained workforce, in order for the jobs created to be filled by nationals rather than foreign workers	National
SDG 5 Gender equality		X	A focus on training more women to participate in various aspects of the blue economy can help enhance gender equality	National
SDG 7 Affordable clean energy		X	Ocean energy is one component of a sustainable blue economy. Trade-offs with management of ecosystems (14.2) have to be managed.	Local National
SDG 8 Economic growth and employment	X		Marine transport can increase productivity and help SIDS and LDCs increase the economic benefits from the use of marine resources	Regional Global
		X	Oceans provide a base for economic activities that can be harnessed by SIDS and LDCs, including fisheries, tourism, renewable energy, exploitation of biological resources, and others	National
SDG 9 Infrastructure, innovation and industrialization	X		Infrastructure can increase productivity and help SIDS and LDCs increase the economic benefits from the use of marine resources. In addition, fostering innovation is an important component of a blue economy	Local
SDG 10 Inequality		X	Increased economic benefits for SIDS and LDCs would contribute to decreasing inter-country inequality	Global
SDG 12 Sustainable consumption and production	X		Actions to create markets for more sustainable leisure tourism can impact tourism in SIDS	National Global
SDG 16 Peaceful and inclusive societies	X		Effective institutions at the international level can help ensure that SIDS and LDCs receive a fair share of benefits from the use of marine resources	Regional Global

Source: Authors' elaboration.

While some of these activities, such as marine biotechnology, have minimal or no environmental impacts, others, such as seabed mining, can be destructive. The World Bank recommends that countries supporting or considering deep sea mining activities proceed with a high degree of caution to avoid irreversible damage to the ecosystem, and ensure that appropriate social and environmental safeguards are in place as part of strong governance arrangements for this emerging industry (World Bank, 2016). Underlying the need for diversified economies are demographic trends such as population growth and rapid coastal urbanization, which fuel the search for food and job security and for alternative sources of minerals and energy, as well as seaborne trade. At the same time, new technologies can offer significant opportunities to tap into new and previously unexploited resources.

4.8 Increase scientific knowledge, develop research capacity and transfer marine technology

SDG target 14.a focuses on increasing scientific knowledge, research capacity and transfer of marine technology to improve the contribution of oceans to

Box 3

Marine biotechnology, scientific education and the blue economy

The positive impacts that scientific cooperation, education, and technology transfer in relation to marine biotechnology can have on a blue economy in a developing nation are demonstrated by a royalty sharing agreement between the University of British Columbia (UBC) and the University of Papua New Guinea (UPNG). In this case, a cancer fighting compound isolated from a sponge led to the construction of potential medicine that went into clinical trials. Royalty payments were used to convert dilapidated student residences into properly equipped research laboratories for PhD and MSc students, and provide the infrastructure to allow UPNG faculty and students to conduct research in the area. Recently, a new drug based on a compound from a PNG sponge has also gone into clinical trials; this drug is being developed by a start-up company in which both UBC and UPNG have equity. Both institutions will receive milestone royalty payments if the drug works in phase II trials and gets approved for use. These provide examples of how cooperative agreements can positively affect the development of research and training in developing countries, and ultimately build a sustainable blue economy (Vierros et al, 2016).

Table 8

Important links of target 14.a with the rest of the SDGs

SDG	From	To	Description of link	Geographic level
SDG 2 Food security		X	Research and technology can help increase the contribution of oceans to food security and nutrition	National Global
SDG 3 Health		X	Ocean-based resources are used for health research and development (medicines, etc.)	National Global
		X	Increased scientific knowledge and research capacity enhances knowledge of health hazards	National Global
SDG 4 Education	X		Education provides tools for managers and enhances capacity around oceans-linked economic activities, science and technology	National
SDG 5 Gender equality		X	Science, technology and innovation can help improve gender equality in ocean-related activities	National
SDG 7 Energy		X	Scientific research and technology transfer can inform the development of ocean-based energy sources	National Global
SDG 9 Infrastructure and industrialization		X	Increased transfer of marine technology can increase national innovation capacity	National Global

Source: Authors' elaboration.

the development of developing countries, in particular SIDS and LDCs.

As highlighted in section 3, science, technology and innovation (STI) are essential for the sustainable use of marine resources. Yet, many gaps exist in ocean-related knowledge, including its interaction with human systems (UN, 2016b, 2017). Increasing marine-related STI capacity has a direct positive impact on national innovation systems (SDG 9) of coastal countries, particularly SIDS and LDCs. Moreover, marine-related STI can have positive effects beyond the activities related to oceans (see Box 3). For example, increased scientific knowledge and research capacity related to oceans could enhance knowledge of health hazards or opportunities associated to marine resources. Science, technology and innovation also contribute to food security (SDG 2) and sustainable energy sources (SDG 7). Improvements in education (SDG 4), at all levels, are fundamental for the development of STI systems.

4.9 Access to resources and markets for small-scale fishers

Target 14.b aims to provide access for small-scale artisanal fishers to marine resources and markets. Small-scale artisanal fisheries are a dynamic and evolving labor-intensive sector encompassing all activities along the value chain – pre-harvest, harvest and post-harvest, to exploit marine and inland water fishery resources (FAO, 2005, 2014b). Estimates suggest that small-scale fishers and related workers comprise over 90 percent of people employed globally in capture fisheries and related activities (World Bank, 2014). The sector employs both men and women in almost equal measure, with high female participation in fish processing and small-scale fish trading operations (Committee on World Food Security, 2014).

Small-scale fisheries contribute to food security and poverty alleviation (FAO, 2014; ESCAP, 2016; World Bank, 2014; UNEP, 2012). That activity is a major source of protein-rich foods for households in coastal communities in some developing countries, particularly SIDS (ECLAC, 2010; United Nations, 2016b). In some developing countries, including SIDS, small-scale fisheries provide more than 60% of protein intake. It also contributes to poverty reduction due to its role in preventing households from falling deeper into poverty and hunger (FAO, 2005).

However, it also has been noted that small-scale fishery activities generate low economic returns for households that depend on those activities. Small-scale fishing communities also face other deprivations, in addition to income poverty, due to other forms of inequality (FAO, 2014b). A challenge identified in this regard is that poverty in coastal communities could lead to over-fishing and degradation of coastal and marine ecosystems (ECLAC, 2003), which could trap these communities in a vicious cycle of poverty and resource depletion (Millennium Ecosystem Assessment, 2005). In some fishing communities, the reduction in the availability of fish has been identified as the main cause of increasing levels of poverty (FAO, 2006).

Some of the policy recommendations to improve the access of small-scale fishers to markets and resources include: empowering the sector's operators through strengthening organizations and collective action in small-scale fisheries (FAO, 2014a), implementing policies and sector development programs, including infrastructure provision, that facilitate business activity and increase incomes without resorting to increasing pressure on fisheries (FAO, 2005a, 2005b; ECLAC, 2010), and improving access to education to foster community development and empowerment (FAO, 2005b).

Many indigenous peoples and their communities also rely on small-scale fisheries. The role of artisanal fisheries in food security and nutrition is often underestimated or ignored, and their product is rarely reported separately in national catch statistics (UN, 2016b). The 2014 FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication seek to enhance the contribution of small-scale fisheries to poverty alleviation, food and nutrition security and economic growth.

Table 9
Important links of target 14.b with the rest of the SDGs

SDG	From	To	Description of link	Geographic level
SDG 1 Poverty		X	Access to marine resources for small-scale artisanal fishers creates local livelihoods and income generation opportunities	Local
SDG 2 Food security and agriculture		X	Access to marine resources for small-scale artisanal fishers enhances local food security	Local
SDG 4 Education	X		Capacity building for artisanal fishers can help secure their access to marine resources	Local National
SDG 5 Gender	X	X	Changes in access to resources and markets for small-scale fishing communities can have positive or negative impacts on gender equality	Local
SDG 10 Inequality		X	Increased access to market and resources by small-scale fishers can help reduce inequality	National
SDG 17	X		Trade rules and trade-related policies impact this target	Global

Source: Authors' elaboration.

For artisanal fishers to be able to access marine resources, access to markets presents challenges and therefore will require a range of actions, including implementing policies that promote business activity without increasing pressure on fisheries, and improving access to education to foster community development and empowerment and legal changes that can benefit small-scale fisheries (UN, 2016b). It is difficult for small-scale operators to ensure homogeneity in quality, safety and handling practices, transport and packaging. Agricultural and fish products are generally more exposed to Non-Tariff Measures (NTMs) than industrial manufactures, due in part to sanitary and phytosanitary measures (SPS). The Aid for Trade initiative and other efforts can encourage exports and value-addition strategies for small scale and artisanal fishers.

4.10 Implementing international law as reflected in UNCLOS

The implementation of UNCLOS interfaces with SDG 16, and especially with targets 16.3 (Promote the rule of law at the national and international levels and ensure equal access to justice for all), 16.6 (Develop effective, accountable and transparent institutions at all levels) and 16.8 (Broaden and strengthen the participation of developing countries in the institutions of global governance). The links go in both directions.

5 Conclusion

The main conclusions of our analysis are the following. First, the ten targets under SDG 14 present strong interrelationships with one another. Many of these are potentially synergistic, which is to say, a good performance on any of them could benefit progress on the others. Yet, the real impact of many targets, as opposed to the desired one, is often variable and heavily depends on the details of design and implementation in the corresponding area. Management of marine and coastal ecosystems is a case in point. Importantly, some of the targets of SDG 14 are mostly at the "receiving end" of the interlinkages and are affected by many of the other targets. A notable example is target 14.7, which vows to increase benefits for SIDS and LDCs of the sustainable use of marine resources. Lack of progress on other SDG 14 targets would affect progress on target 14.7 negatively. Conversely, target 14.a has the potential to benefit many other targets of SDG 14.

Second, our study shows that a policy relevant analysis of linkages between SDG 14 and other SDGs has to be undertaken at the level of individual SDG 14 targets. The ten targets link to different SDG areas; while some have limited connections to other goals, for others such as management of coastal and marine ecosystems (14.2) or fish stocks (14.4), the map of interlinkages is quite complex. Taking SDG 14 as a whole, our analysis reveals a great number of linkages with the broader system of SDGs. Indeed, it is possible to identify linkages with all the other SDG areas. Among those, linkages to SDGs 1, 2, 3, 8, 9, 12, 13, 15 and 16 are perhaps the most important systemically. The links go in both directions: while progress on many SDGs will impact the oceans, it is also true that the way oceans are managed will impact a number of other goals. It is therefore critical to take these links into account when focusing on progress made on SDG 14. Generally speaking, the links from economic activity (SDGs 8, 9, 11 as well as agriculture) to SDG 14 are in the form of pollution loads, increased ocean acidification, and pressure on marine resources. These classes of threats to oceans have long been identified, and they should be taken into account in any assessment of progress on SDG 14. The same could be said for climate change (SDG 13).

Importantly, while many interlinkages identified here have the potential to be addressed through synergies, some of them involve trade-offs and may not be amenable to so-called "win-win" solutions. The nexus of climate change (SDG 13), food security (SDG 2) and healthy oceans (SDG 14) illustrates this. Available projections for human population and food production, coupled with projected negative impacts of climate change on terrestrial crop production, indicate that in the long run, meeting the food security goal is likely to imply increased pressure on fish stocks and the ecosystems in which they occur. While it is possible that strategies exist to do this in ways that are "sustainable" in the sense that the harvesting strategies can be continued in the long term, marine ecosystems will be very different from their pristine status, and this is likely to generate tensions with objectives that relate to marine protection (Rice and Garcia, 2011).[4] Identifying and acting on the most important trade-offs among SDG 14 targets as well as between SDG 14 and other goals will necessitate work across disciplines and professional areas, to a degree that does not exist today (Rice and Garcia, 2011).

Third, some important factors affecting the sustainable use of oceans are addressed only tangentially in the SDGs (as opposed to other intergovernmental texts such as the outcome document of the Rio+20 conference). Examples include sea-level rise and other impacts of climate change on marine ecosystems, and the role of regional fisheries management organizations. In general, the institutional dimension of oceans is highly complex, and will have a critical impact on progress in most of the target areas of SDG 14. A critical dimension of a forward-looking assessment of prospects for oceans should include an assessment of current gaps in the implementation of international law covering the various issues at stake. Some have argued that fuller implementation of existing legal frameworks could achieve a great deal towards many of the SDGs (Garcia, Rice and Charles, 2014). In addition, work towards developing new legal frameworks, both nationally and internationally (e.g. the current discussions at the United Nations on an international legally binding instrument under UNCLOS on the conservation and sustainable use of marine biodiversity of areas beyond national jurisdiction) have the potential to enhance implementation of SDG 14.

A critique of the approach adopted for this paper is that our tables seem to imply that "everything is connected to everything", which is not useful as a policy message. While this is true at a certain level, at another level complexity is a reality, and denying it is not going by itself to generate better policy-making. One could actually argue that oversimplification, for example in terms of conservation approaches, has in the past been the cause of unfortunate outcomes

4 We thank an anonymous referee for highlighting the importance of existing trade-offs for the policy discussion.

because connections to various social, economic and environmental dimensions were not adequately considered. One concrete area where our approach may be useful to policy-making at the national level is in helping policy processes to identify the relevant stakeholders and interest groups that should be part of discussions on policy issues. From the analysis presented here, it is quite clear that those vary across the SDG 14 targets.

Another argument against our approach is that presenting issues according to the logic of the SDG 14 targets leads to a confusing and disorganized story, because SDG targets were chosen politically and do not reflect neat analytical categories. While we readily acknowledge this, it does not change the fact that analysis of progress on the SDGs is for a large part going to be done on the basis of the targets. It therefore seems critical to us that the massive body of scientific knowledge that exists on oceans be mapped to each ocean-related target in the agenda, whether or not this generates repetitions or duplications. In our opinion, doing so is a critical task of a well-functioning science-policy interface on oceans. We think our preliminary mapping provides a basic frame for more systematic analyses in this area.

In years to come, it would be important to develop research maps documenting the status of knowledge on the various linkages that are highlighted here. Such mappings should aim to clarify disagreements among scientists and uncertainty levels that exist on specific linkages. They may also reveal that some linkages that are important from a policy perspective have only received limited attention from the scientific community. The limited analysis of UN reports and scientific publications conducted for this paper thus clearly needs to be complemented by more systematic efforts. Additional information about existing linkages and how they operate could be found in other reports produced by the UN system or specialized institutions and processes dealing with oceans such as the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), the Intergovernmental Oceanographic Commission (IOC), other existing assessments as referenced by the Assessment of Assessments (UNEP and IOC-UNESCO, 2014) as well as a systematic scanning of the World Ocean Assessment (UN, 2016b). Additional scanning of the scientific literature may be necessary in areas not covered by those processes.

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