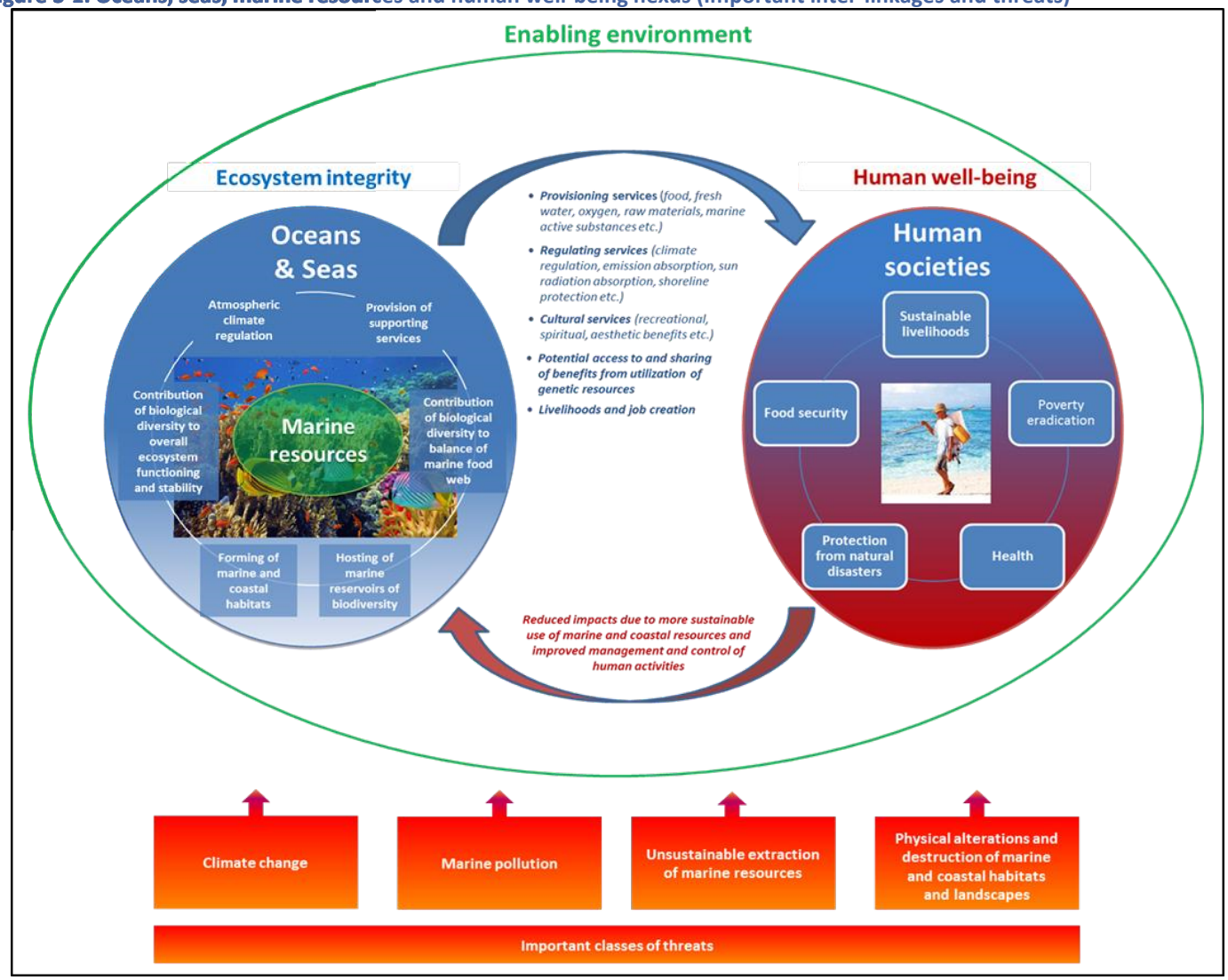
# Chapter 3. The Oceans, Seas, Marine Resources and Human Well-being Nexus

The present chapter aims to demonstrate the necessity of using an integrated approach when dealing with the "oceans, seas, marine resources[126] and human well-being" nexus at the global, regional, national and local levels. It identifies important inter-linkages between nexus areas (Section 3.1) and elaborates on important classes of threats (Section 3.2) (Figure 3-1). It examines the scientific coverage of interlinkages and threats, lists illustrative scientific reports and indicates areas for further research. Furthermore, it documents selected case studies illustrating inter-linkages and the benefits of integrated approaches for implementation (Section 3.3).

The chapter is based on the knowledge and expertise of contributing scientists and UN staff and based on a review of the scientific literature. It is written with the full understanding that the First Global Integrated Marine Assessment (the World Ocean Assessment)[127] (see Box 3-2) will provide a much more detailed analysis of the topics at hand. Annex 1 (Extended versions of Table 3-1, 3-3, 3-4) (available online[128]) contains extended versions of the tables with supplementary illustrative scientific reports, case studies and contributions submitted by experts to give readers the ability to gain a deeper insight into specific topics. The scientific reports listed in this chapter and Annex 1 (Extended versions of Table 3-1, 3-3, 3-4) are of illustrative nature and are not meant to be exhaustive.

**Figure 3-1. Oceans, seas, marine resources and human well-being nexus (Important inter-linkages and threats)[129]**



In order for oceans, seas and marine resources to successfully contribute to human well-being, ecosystem integrity[130], with properly functioning biogeochemical and physical processes, is required. This does not require unperturbed systems, but systems that have not suffered serious or irreversible harm. Ecosystem integrity allows for the provision of supporting ecosystem services which, in turn, are the bases of important regulating, provisioning and cultural ecosystem services that are of crucial importance for humans. Whereas the benefits provided by oceans, seas and marine resources are important to all people, vulnerable groups, including the poor and indigenous peoples, with a high dependency on natural resources and ecosystem services may have their well-being especially tied to these benefits.

The following illustrative examples underline the importance of oceans, seas and marine resources for human well-being:

- Over 3 billion people depend on marine and coastal resources for their livelihoods.[131]
- Fish provide 4.3 billion people with at least 15% of their intake of animal protein.[132]
- At least 90% of the volume of global trade is seaborne.[133]
- Approximately 50% of all international tourists travel to coastal areas. In some developing countries, notably Small Island Developing States (SIDS), tourism can account for over 25% of GDP.[134]
- The global oceans-based economy is estimated at between USD 3-6 trillion/year.[135]
- Oceans capture and store about 30% of carbon dioxide produced by humans.[136]
- Mangroves and coral reefs offer shoreline protection. Global coral reefs protect around 150,000 km of shoreline in more than 100 countries and territories.[137]
- Marine phytoplankton produces 50% of oxygen on Earth.[138]

**The link between oceans, seas and marine resources and human well-being is not one-sided.** While an increase in human well-being is frequently generated at the cost of ecosystem integrity, it can also potentially reduce the negative anthropogenic impacts on the marine environment, for example due to a more sustainable use of resources, changes in production and consumption patterns and improved management and control of human activities, for which good governance and an enabling environment are required (see Box 3-1).

**Box 3-1. Enabling environment[139]**

An enabling environment comprises a multitude of elements, including political will; effective legal and policy frameworks, institutions and cooperation mechanisms; compliance with, and enforcement of, UNCLOS[140] and its implementing agreements, as well as other relevant instruments; national, regional, global action plans, strategies and policies aimed at sustainable development; social and economic security and opportunities; stakeholder involvement and empowerment; increased cross-sectoral cooperation and coordination at all levels; decent work conditions; capacity development; scientific capacity; technology transfer and advancement; education and training; knowledge sharing and awareness raising; and changes in (consumer and producer) behaviour.

The importance of oceans for sustainable development is widely recognized by the international community and embodied in chapter 17 of Agenda 21, the Johannesburg Plan of Implementation and various decisions taken by the Commission on Sustainable Development. The Millennium Ecosystem Assessment emphasizes that all humans depend on the Earth's ecosystems and the services they provide.[141] In the Rio+20 outcome document, *The Future We Want*, Member States called for "holistic and integrated approaches to sustainable development that will guide humanity to live in harmony with nature and lead to efforts to restore the health and integrity of the Earth's ecosystem". In this context, they stressed, among others, the importance of "the conservation and sustainable use of the oceans and seas and of their resources for sustainable development, including through their contributions to poverty eradication, sustained economic growth, food security and creation of sustainable livelihoods and decent work…". Accordingly, the proposal of the Open Working Group on sustainable development goals submitted to the United Nations General Assembly in August 2014 contains sustainable development goal (SDG) 14 which aims to "Conserve and sustainably use the oceans, seas and marine resources for sustainable development".[142] The idea of a stand-alone ocean SDG was previously supported by various organizations and academic institutions.[143] A recent report released by the International Council for Science and the International Social Science Council confirmed that SDG 14 is directly or indirectly connected to all other SDGs which underlines the concept of a network of SDGs presented in Chapter 2 of the present report.[144]

**Box 3-2. First World Ocean Assessment**

The Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socio-economic Aspects was established by the United Nations General Assembly to strengthen the regular scientific assessment of the state of the marine environment in order to enhance the scientific basis for policymaking. The start-up phase to the Regular Process, called the "assessment of assessments", was concluded in 2009.[145] A census of existing ocean assessments was conducted and consolidated in the Gramed database.[146] The output of the first cycle of the Regular Process, the First Global Integrated Marine Assessment ("World Ocean Assessment")[147], is under preparation and will be considered by the Ad Hoc Working Group of the Whole in September 2015 and a summary thereof will be considered by the United Nations General Assembly at its seventieth session. It is expected to provide an overall assessment of the scale of human impact on the oceans and the overall value of the oceans to humans; the main threats to the marine environment and human economic and social well-being; the needs for capacity-building and effective approaches to meeting such needs; and the most serious gaps in knowledge and possible ways of filling them.

Apart from supporting the World Ocean Assessment, ocean scientists are informing other intergovernmental processes and meetings, including the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea and the Ad Hoc Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction (see Box 3-3).

**Box 3-3. Ad Hoc Open-ended Informal Working Group**

In recent years, the international community has become increasingly aware of the range of services provided by marine ecosystems and of the rich biodiversity of pelagic and benthic ecosystems beyond the limits of national jurisdiction, namely in the high seas[148] and the Area[149]. The Ad Hoc Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction has been meeting regularly since 2006. The last meeting of the Working Group, held in January 2015, stressed the need for a comprehensive global regime to better address the conservation and sustainable use of marine biodiversity beyond areas of national jurisdiction and resulted in the recommendation to develop an international legally-binding instrument under the United Nations Convention on the Law of the Sea.[150]

## 3.1. Interlinked issues: oceans, seas, marine resources and human well-being

Regarding the overall scientific coverage of the nexus and its threats (Section 3.2), contributing experts note that the number and quality of assessments are very variable in terms of the geographic range or areas they cover. Some research areas and regions are more poorly covered than others due to a lack of or uneven distribution of financial support, technological and human resources and capacities and/or logistical limitations due to habitat inaccessibility (remote areas or deep sea). Research tends to be very results-driven, so that areas where clearly definable results can be demonstrated in a short amount of time tend to be more pursued and financed. There is a need for more integrated study of the oceans by teams of natural and social scientist to propose and assess different sustainable development scenarios. However, natural and social scientists seldom work together due to their use of different research methods, different geographical scales of research and the fact that funding is often only targeted at one type of research. Some areas are at the forefront of new science and need more time for research to mature. Another problem identified by experts is the lack of free and openly available data. Quite few data remain unpublished or are not available through open access databases. While the experts' priorities for future research vary according to their expertise, important research areas mentioned by several experts were: (1) understanding the direct, cumulative and interacting effects of anthropogenic threats on biodiversity, ecosystem functioning and stability and human well-being; (2) qualitative and quantitative evaluation of ecosystem services and their connection to human well-being; (3) importance of biodiversity (at all levels of food web) for ecosystem functioning and stability; (4) impact of different policy and management options on sustainable ocean management; (5) adaptive capacity of ocean-dependent communities and livelihoods vis-à-vis threats.

Table 3-1 summarizes some important inter-linkages among nexus areas and lists illustrative scientific reports, as well as areas for further research suggested by contributing experts. Contributing experts estimate the scientific coverage of oceans, seas and marine resources as being rather developed, notwithstanding the fact that large areas of the oceans are unexplored and unknown forms of marine life and their habitat remain to be discovered. The scientific coverage of the impact of ecosystem integrity on human well-being is seen as being rather developed with regard to the creation of jobs and sustainable livelihoods, but weak with regard to the evaluation of benefits derived from marine resources and ecosystem services. This illustrates a need for more systematic global and regional

fully integrated scientific assessments addressing the nexus. The contribution of oceans, seas and marine resources to human well-being should be properly acknowledged and operationalized for policy recommendation and design. The integration of mapping efforts of ecosystem services that are undertaken by separate entities[151] could be a potentially beneficial assessment tool, which is currently being undertaken by the World Ocean Assessment.

**Table 3-1. Important inter-linkages between oceans, seas, marine resources and human well-being**

| **Oceans, seas marine resources (ECOSYSTEM INTEGRITY)** | | |
|---|---|---|
| Inter-linkages | Illustrative scientific reports* | Further research areas suggested by contributing experts: |
| ***Biogeochemical and physical processes***<br><br>Hosting of marine reservoirs of biodiversity<br><br>Forming of coastal and marine habitats, including nursery grounds<br><br>Provision of supporting services (nutrient cycling, carbon cycling/ sequestration, oxygen provision, soil formation, primary production etc.)<br><br>Contribution of biological diversity to balance and maintenance of marine food web<br><br>Contribution of biological diversity to overall ecosystem functioning and stability<br><br>Atmospheric climate regulation | • UN World Ocean Assessment (2015)[152]<br>• Census of Marine Life[153]<br>• Ocean Biogeographic Information System (OBIS)[154]<br>• WWF Living Planet Index[155]<br>• National Research Council of the National Academies (2015). Sea Change: 2015-2025 Decadal Survey of Ocean Sciences.<br>• Gamfeldt et al. (2014). Marine biodiversity and ecosystem functioning: what's known and what's next?<br>• IPCC (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 6. Ocean Systems.<br>• Secretariat of CBD (2014). Global Biodiversity Outlook 4.<br>• Global marine biodiversity assessment and outlook (2010).<br>• UNEP, UNESCO-IOC (2009). An Assessment of Assessments. Findings of the Group of Experts.<br>• Kondoh, M. (2003). Foraging Adaptation and the Relationship between Food-Web Complexity and Stability. | • Assessing actual direct, indirect and cumulative impacts of human activities on marine and coastal ecosystems, including deep sea ecosystems; assess resilience of marine and coastal ecosystems<br>• Sustainable approaches to marine aquaculture<br>• Indirect and cumulative effects of biodiversity loss on ecosystem functioning and stability and role of keystone species<br>• Modeling of production functions for multiple ecosystem services of critical marine habitats, especially coral and bivalve reefs, seagrass beds, mangroves and marshes<br>• Valuing carbon storage capacity of marine ecosystems and potential to increase sequestration through habitat protection and restoration<br>• Ecological effects of emerging activities, such as ocean energy development, ocean geo-engineering (e.g. $CO_2$ injection, ocean fertilization) and open ocean aquaculture<br>• Goods and services provided by deep sea ecosystems and their real values<br>• Biodiversity role in ecosystem functioning, stability and resilience, including the roles of genetic diversity and functional redundancy<br>• Diversity of marine bacteria, microbes, and viruses and their role in ecosystem functioning<br>• Influence of habitat-forming species on biodiversity throughout their range; their response to climate change and consequences for associated biodiversity; resilience of various habitat types and communities to perturbation and capacity to recover from it<br>• Analyze how global changes interact currently and in the future with changing patterns in biodiversity and ecosystem functioning<br>• Accelerate discovery as much biodiversity can be lost before it has been discovered<br>• Baselines for monitoring and evaluation of biomass and/or distribution of stocks (benthic and pelagic species)<br>• Reproduction of important marine species<br>• Marine species lifecycle and habitats of commercially important species<br>• Development of methodologies for assessment of marine ecosystems and open ocean<br>• Functional links between terrestrial, coastal and marine ecosystems, and consequences of degradation on neighbouring systems |
| **Oceans, Seas and marine resources (*Ecosystem Integrity*) → HUMAN WELL-BEING** | | |
| Inter-linkages | Illustrative scientific reports* | Further research areas suggested by contributing experts: |
| ***Creation of livelihoods and jobs***<br><br>[e.g. in fisheries and aquaculture, maritime transportation, shipbuilding, ports and related services, coastal developments, tourism, oil, gas, mining industries and emerging sectors (e.g., offshore renewable energy[156])] | • UN World Ocean Assessment (2015)[157]<br>• Mapping Ocean Wealth[158]<br>• UNCTAD (2014). Review of Maritime Transport.<br>• Begossi (2013). Small-scale Fisheries and Biodiversity: Alleviating Poverty and Conserving Natural Resources.<br>• UNEP et al. (2012). Green Economy in a Blue World.<br>• Secretariat of CBD (2009). Biodiversity, Development and Poverty Alleviation. | • Census of small-scale fisheries; better document impact of small-scale fisheries and small and medium-scale aquaculture enterprises; improve availability and quality of disaggregated data<br>• Census of people depending on coastal resources for consumption/sale<br>• Mapping and qualitative and quantitative evaluation of ecosystem services<br>• Quantification of distribution of wealth generated by newer industries (e.g. eco-tourism) among communities, gender etc.<br>• Role of women in fisheries<br>• Impact of increasingly connected markets and consumption on local livelihoods, food security and resource management<br>• Economic consequences of ecosystem responses to changing biodiversity<br>• Economic and environmental viability of regional wave and other renewable energy devices<br>• Green economy approach in ocean sectors; Contribution of blue natural capital to macroeconomics |

| | | |
|---|---|---|
| | Recognizing the role of Biodiversity for Human Well-being.<br>• Charles (2001). Sustainable fishery systems. | • Distribution of power among participants in marine sectors/industries and ways to address inequities where they occur<br>• Measurement of socio-economic value of marine and coastal tourism<br>• Adaptive capacity of communities and livelihoods vis-a-vis threats<br>• Undertake risk assessments and identify hazardous activities in specific fish value chains that pose risks to young people /support child labour |
| ***Provisioning services*** (food, fresh water, raw materials, pharmaceutical compounds)<br>***Regulating services*** (climate regulation, emission absorption and storage, shoreline protection)<br>***Cultural services*** (recreation, spiritual and religious sites, aesthetics) | • UN World Ocean Assessment (2015)[159]<br>• Ocean Health Index[160]<br>• High-level Panel of Experts on Food Security and Nutrition (2014). Sustainable fisheries and aquaculture for food security and nutrition.<br>• IUCN (2014). The Significance and Management of Natural Carbon Stores in the Open Ocean – A Summary.<br>• UNEP, UNESCO-IOC (2009). An Assessment of Assessments. Findings of the Group of Experts.<br>• Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-being: Synthesis. | • Map and inventory of ecosystem services; role for human well-being - links and interdependencies<br>• More comprehensive valuation of regulatory services provided by coastal habitats<br>• Systematic qualitative and quantitative evaluation of ecosystem services, including aboriginal usage, views and values<br>• Better quantification of the role of seafood in food security<br>• Connection between high seas and ecosystem services in coastal areas<br>• Extended research into cultural ecosystem services<br>• Impact of global threats on provision of ecosystem services |
| ***Potential access to and fair and equitable sharing of benefits arising from the utilization of genetic resources*** and associated traditional knowledge, as internationally agreed[161] | • ABS Capacity Development Initiative (2014). Relevance of marine bioprospecting for access and benefit sharing frameworks.<br>• German Advisory Group on Global Change (WBGU) (2004). World in Transition. Fighting Poverty through Environmental Policy.<br>• IUCN (2004a). Access to genetic resources and benefit sharing: Key questions for decision makers. | • Evaluation of marine genetic resources with focus on commercially viable species (e.g. algae and extremophiles)<br>• Role and impacts of bioprospecting<br>• Development of low-tech methods for screening for product potential from marine genetic resources<br>• Develop methodologies for traceability of products from marine genetic resources<br>• Examine access and benefit-sharing systems for their consistency, effectiveness and feasibility |
| **HUMAN WELL-BEING → Oceans, Seas and marine resources (*Ecosystem Integrity*)** | | |
| Inter-linkages | Illustrative assessments* | Further research areas suggested by contributing experts: |
| Within an enabling environment (Box 3), reduced negative impacts on marine and coastal ecosystems due to more sustainable use of marine and coastal resources and improved management of human activities | • UN World Ocean Assessment (2015)[162]<br>• Secretariat of CBD (2010). Linking biodiversity conservation and poverty alleviation: A State of Knowledge Review.<br>• Langmead et al. (2007). European Lifestyles and Marine Ecosystems: Exploring challenges for managing Europe's seas.<br>• FAO (2005). Reducing fisherfolk's vulnerability leads to responsible fisheries. | • Effects of changes in lifestyle (e.g., production, consumption, social organization) on sustainability of marine resource use<br>• Incentives for changing behaviour such as payment for ecosystem services and participatory management schemes<br>• Data availability and resolution at different levels and geographic spread<br>• Synthesis of lessons from (successful) projects<br>• Cost – benefit analysis of effects of coastal tourism<br>• Impacts of human sectoral activities on marine and coastal resources and ecosystem integrity<br>• Effects of improved management of human activities on marine and coastal resources<br>• Reaction of communities to imposition of management measures on their livelihoods, and ways to increase compliance and cooperation between regulators and those being regulated<br>• Comparison of ports to ascertain their performances in terms of corporate social responsibility and sustainability goals |

**Further illustrative scientific reports are available in Annex I.*[163]

While some efforts are undertaken to account for ecosystem services[164], the quantitative evaluation or monetization of ecosystem services represents a challenge, especially with respect to cultural services. Given such limitations, qualitative ways of investigating the meaning, relevance and significance of ecosystem services should be promoted. The ocean health index (OHI)[165] is one example of a possible translation of the provision of ecosystem services into traceable and quantifiable indicators (see Box 3-4).

**Box 3-4. The Ocean Health Index (OHI) [166]**

The Ocean Health Index (OHI), developed by 65 scientists/ocean experts and partners[167], is a measure of ocean health that includes people as part of the ocean ecosystem. It compares and combines all dimensions of ocean health -biological, physical, economic and social- in order to generate a snapshot of the health of the oceans. The OHI evaluates the condition of marine ecosystems according to 10 goals, which represent important ecological, social, and economic benefits that a healthy ocean can provide: (1) Food Provision, (2) Artisanal Fishing Opportunities, (3) Natural Products, (4) Carbon Storage, (5) Coastal Protection, (6) Sense of Place, (7) Coastal Livelihoods & Economies, (8) Tourism & Recreation, (9) Clean Waters and (10) Biodiversity. The Index score is the average of the 10 goal indices.

Despite some evidence provided by projects and case studies[168], contributing experts point to a lack of scientific information on the potential contribution of improvements in human well-being to reduced anthropogenic impacts on oceans, seas and marine resources. They suggest that further research needs to be undertaken on the effects of changes in lifestyle (e.g., production, consumption, social organization) on the sustainability of marine resource use. A more systematic analysis of lessons-learned from projects and initiatives could provide information and support the sharing of best practices.

### 3.2. Impact of important classes of threats on the oceans, seas, marine resources and human well-being nexus

Oceans, seas and marine resources are increasingly threatened, degraded or destroyed by human activities, reducing their ability to provide crucial ecosystem services.[169] Important classes of threats identified by contributing experts were climate change, marine pollution, unsustainable extraction of marine resources and physical alterations and destruction of marine and coastal habitats and landscapes.

One estimate found that at least 40% of the global oceans are heavily affected by human activities.[170] A recent global analysis of threats to marine biodiversity warns against a possible future marine mass extinction event driven by increased human uses of the oceans.[171] Already today, 30% of the world's fish stocks are over-exploited, while more than 50% are fully exploited.[172] Coastal habitats are under pressure, with approximately 20% of the world's coral reefs lost and another 20% degraded. Mangroves have been reduced to between 30 to 50% of their historical cover, impacting biodiversity, habitat for fisheries, coastal protection from severe weather and tide events and carbon sequestration potential. Some 30% of seagrass habitats are estimated to have disappeared since the late 1800.[173] Over 80% of the world's 232 marine eco-regions report the presence of invasive species, which is considered the second most significant cause of biodiversity loss on a global scale.[174]

The deterioration of coastal and marine ecosystems and habitats is negatively affecting human well-being worldwide, with more severe and immediate impacts on the vulnerable groups, including the poor, women, children, and indigenous peoples, due to their often high dependency on natural resources, lack of alternative options, and inability to protect themselves from natural disasters and other threats. Coastal regions and SIDS are particularly vulnerable to these challenges as oceans, seas and marine resources play a central role in their culture, while at the same time being tightly linked to their economies.

Given the Earth's limited natural resource base as suggested by the concept of "planetary boundaries"[175], the foreseen global population growth to 9.6 billion people by 2050[176], the persistence of unsustainable consumption and production patterns in high-income countries, and the increased economic "catching up" of developing countries with related increases in resource demands, are anticipated to aggravate the situation if no adequate counter measures are taken.

Coastal regions are more densely populated and experience higher rates of population growth and urbanization than the hinterland. This trend is expected to continue.[177] Poorly planned and managed developments of coastal areas can have detrimental impacts on local marine ecosystems and the services they provide.

Negative impacts of climate change and other threats are already felt in coastal areas around the world and are expected to increase.[178] More than 600 million people (around 10% of the current global population) live in coastal areas that are less than 10 meters above sea level. With regard to sea level rise, almost two-thirds of the

world's cities with populations of over five million are located in at-risk areas.[179] With sea level projected to rise further, large numbers of people might have to relocate and several small island developing States (SIDS) are at risk of being submerged. It is even possible that areas - and countries - might become uninhabitable long before they are submerged (e.g. due to intrusion of saltwater into coastal aquifers).[180]

Important classes of threats identified by contributing experts and their drivers and pressures are illustrated in Table 3-2, an adaptation of the Drivers-Pressures-State-Impacts-Responses (DPSIR) framework which intends to organize information about the state of the environment and reflects the complex chain of cause-and-effect in the interactions between society and the environment.[181]

**Table 3-2. Drivers and pressures of important classes of threats affecting the nexus**

| | Climate change | Marine pollution | Unsustainable extraction of marine resources | Physical alterations and destruction of marine and coastal habitats and landscapes |
|---|---|---|---|---|
| **Land- and marine- based human activities [Drivers]** | • Any activities leading to release of greenhouse gas into atmosphere (e.g., combustion of fossil fuels, animal rearing, land-use change)<br>• Potential impacts of emerging activities, such as ocean geo-engineering (e.g. $CO_2$ injection, ocean fertilization) | • Agriculture<br>• Aquaculture<br>• Industrial activities<br>• Maritime transport<br>• Fishing operations<br>• Dumping at sea<br>• Abandoned, lost and otherwise discarded fishing gear (ALDFG)<br>• Solid waste disposal<br>• Industrial and municipal sewage discharge<br>• Damming of rivers and lakes, dredging<br>• Offshore infrastructure; oil and gas production; seabed mining | • Overfishing<br>• IUU fishing, including harmful subsidies that contribute to IUU fishing and overcapacity; abusive and unsafe labour practices and exploitation of poor migrant workers<br>• Destructive fishing practices, including harmful bottom trawling, use of explosives and poisons<br>• Inappropriate deployment/deployment in wrong areas of fishing gear<br>• Ballast water (shipping)<br>• Deep sea mining, offshore oil and gas drilling | • Unsustainable coastal development<br>• Submarine infrastructure (e.g. cables)<br>• Unsustainable tourism and recreational activities<br>• Shipping/Fishing operations in fragile or vulnerable marine areas<br>• Harvesting by local communities for building materials and energy<br>• Unsustainable aquaculture<br>• Dredging / marine sediment extraction (e.g. sand removal)<br>• Potential impacts of emerging activities, such as ocean geo-engineering (e.g. $CO_2$ injection, ocean fertilization)<br>• Land reclamation<br>• Beach nourishment |
| **Pressures** | • Ocean warming<br>• Ocean acidification<br>• Sea level rise<br>• Changes in circulation patterns (ocean currents)<br>• Increased frequency and intensity of weather and climate extremes<br>• Changes in hydrological cycles (e.g. freshwater flow, water storage, evaporation) | • Introduction of:<br>• Heavy metals<br>• Persistent organic pollutants (POPs)<br>• Pesticides<br>• Nutrients (nitrogen and phosphorus)<br>• Oil<br>• Plastics<br>• Munitions<br>• Hazardous substances<br>• Radioactive material<br>• Anthropogenic underwater noise<br>• Other particulate matter<br>• Alien invasive species | • Seabed disturbances or damage<br>• Removal of aggregates | • Seabed disturbances or damage<br>• Changes in sediment fluxes |

Table 3-3 summarizes the impact of important classes of threats on the nexus, enumerates some illustrative scientific reports and contains areas for further research suggested by contributing experts.

**Table 3-3. Impact of important classes of threats on oceans, seas, marine resources and human well-being nexus**

| **Climate change** (caused by anthropogenic greenhouse gas emissions) **(I)** | | |
|---|---|---|
| Impact on Oceans, Seas and Marine Resources | Illustrative scientific reports* | Further research areas suggested by contributing experts: |
| • Change in ocean temperature<br>• Change in ocean salinity<br>• Changes in stratification<br>• Reduction of oxygen level<br>• Increasing acidification of ocean water<br>• Increased flooding and inundation, coastal erosion and coastal squeezing, saltwater intrusion in coastal aquifers<br>• Melting of permafrost contributing to release of methane (enhancing greenhouse gas effect)<br>• Decreased capacity to absorb and store greenhouse gas emissions<br>• Decline and loss of marine species<br>• Change in species range and survivorship due to changes in habitat and living conditions<br>• Change in resilience and adaptation capacity<br>• Changes in migratory patterns of fish stocks (increasingly poleward distribution of many marine species)<br>• Degradation or destruction of marine and coastal wildlife habitats, including nesting and spawning areas and nursery grounds | • McCauley et al. (2015). Marine defaunation: Animal loss in the global ocean.<br>• IPCC (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability.<br>• Secretariat of CBD (2014). An Updated Synthesis of the Impacts of Ocean Acidification on Marine Biodiversity.<br>• Doney et al. (2012). Climate Change Impacts on Marine Ecosystems.<br>• Scientific and Technical Advisory Panel (STAP) (2011). Hypoxia and Nutrient Reduction in the Coastal Zone. Advice for Prevention, Remediation and Research.<br>• Halpern et al. (2007). Evaluating and ranking the vulnerability of global marine ecosystems to anthropogenic threats. | • Polar, Antarctic and Greenland ice sheet dynamics<br>• Downscaling of global climate model to regions<br>• Modelling of population change and resulting impacts on natural environment/resources<br>• Role of ecosystems in adaptation to climate change<br>• Ocean/climate dynamics (AMOC, PMOC, El Nino, etc.)<br>• Increase model resolution of boundary currents, shelf circulations and mesoscale dynamics in climate projections<br>• Establish observation programs for time series of volume and heat transport of ocean currents; Expand ocean climate observations to validate other datasets, ground truth satellite observations, verify models and improve understanding of ocean processes and heat fluxes; Monitoring of sea level rise at national/regional level (for model validation)<br>• Long term measuring and monitoring of ocean acidification [e.g., projections of spatial and temporal variability in its progress; impacts on marine biodiversity, incl. marine food web; indirect effects (e.g. on behaviour of marine species)]<br>• Impact on biodiversity and consequence for ecosystem functioning and stability; multispecies and food web models of climate change impacts on sustainable (re)production of marine resource; study place-based changes in species composition<br>• Study (shifts in) distribution and abundance of indicator species and experimental transplants to recover depleted habitats<br>• Improved economic evaluation of costs and benefits of climate change impacts on marine systems, and on their distribution<br>• Study scope for adaptation of marine biota to climate change; identification of resilience enhancing measures<br>• Ecological effects of emerging activities, such as ocean geo-engineering (e.g. $CO_2$ injection, ocean fertilization) and open ocean aquaculture<br>• Storage and sequestration of carbon in coastal and marine ecosystems |
| **Climate change** (caused by anthropogenic greenhouse gas emissions) **(II)** | | |
| Implications for Human Well-being | Illustrative scientific reports* | Further research areas suggested by contributing experts: |
| • Increased vulnerability of local communities due to undermined natural protection barriers and damage or destruction of human settlements and infrastructure, including coastal transport infrastructure, services and operations (ports and other assets); loss of coastal investments; displacement of local communities<br>• Decreased availability of freshwater<br>• Reduced wild food fish availability - increased food insecurity and reduced sources of livelihood and employment (small-scale | • FAO (2014). Climate Change Adaptation in Fisheries and Aquaculture.<br>• High-level Panel of Experts on Food Security and Nutrition (2014). Sustainable fisheries and aquaculture for food security and nutrition.<br>• IPCC (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability.<br>• Ruckelshaus et al. (2013). | • Long-term monitoring and related integrative research (e.g. climate change and conflict)<br>• Coastal vulnerability assessments<br>• Develop realistic projections of impacts on communities, including climate-induced migration<br>• Identify ways to enhance resilience of communities; (cost benefit) analysis of adaptation measures/strategies, including specific strategies for vulnerable groups<br>• Research on how ecosystem based adaptation, and adoption of low cost good practices can reduce risks (and costs) of climate change impacts |

| | | |
|---|---|---|
| fisheries particularly affected)<br>• Loss of low-lying agricultural land or homeland; decreased availability of useable/arable land<br>• Decreased seed and feed availability for aquaculture as alternative livelihood - decreased productivity undermining food security<br>• Reduced attractiveness of destination and quality of tourist experience –reduced sources of employment and revenue<br>• Increase of vector-borne (e.g. through mosquitoes and marine invertebrates) and water borne diseases (contact with contaminated water/food) in coastal areas | Securing ocean benefits for society in the face of climate change.<br>• WMO (2013): The Global Climate 2001-2010: A Decade of Climate Extremes.<br>• World Bank (2013). Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience.<br>• FAO/OECD (2012). Building resilience for adaptation to climate change in the agriculture sector. Proceedings of a Joint FAO/OECD Workshop. | • Equity effects of climate change<br>• Identification of high priority coastal ecosystems for protection and restoration to reduce coastal community vulnerability<br>• Effect of on tourism sector in coastal areas<br>• Assess vulnerability of coastal transport infrastructure, services and operations (ports and other assets) at local level<br>• Conduct research on gender-specific impacts of climate change |
| **Marine pollution from marine and land-based sources (I)** | | |
| Impact on Oceans, Seas and Marine Resources | Illustrative scientific reports* | Further research areas suggested by contributing experts: |
| • Creation of low oxygen “hypoxic” conditions, harmful algal blooms and dead zones and changes of ecosystems due to eutrophication<br>• Decreased sea water quality<br>• Accumulation of toxins in food web<br>• Contamination with toxic chemicals causing illnesses or death of marine species<br>• Spilled oils affecting animals and plants both from internal exposure (ingestion or inhalation) and from external exposure (skin and eye irritation) (e.g. reducing ability to maintain body temperatures)<br>• Decline and loss of marine species<br>• Degradation or destruction of marine and coastal wildlife habitats, including nesting and spawning areas and nursery grounds<br>• Potential effects on growth, reproduction and trophic interactions, including effect of hormones and pharmaceuticals in watersheds on estuaries and coastal animal populations<br>• Alien invasive species may outcompete local marine species and threaten marine food web | • UN World Ocean Assessment (2015)[182]<br>• UNEP (2014). Plastic Debris in the Ocean.<br>• Wright et al. (2013).The physical impacts of microplastics on marine organisms: a review.<br>• Secretariat of CBD (2012). Scientific Synthesis of the Impacts of Underwater Noise on Marine and Coastal Biodiversity and Habitats.<br>• IUCN (2010). Marine Menace: Alien invasive species in the marine environment.<br>• UNEP (2009). Marine Litter: A Global Challenge.<br>• GESAMP (2009). Pollution in the open oceans: a review of assessments and related studies. | • Census of heavily populated areas with important industrial activities and fisheries; mapping of risk areas where industries that discharge materials are located<br>• Better understanding of ecology of pollution impacts and quantification of impacts, especially extrapolating from individual impacts to population and ecosystem impacts<br>• Cumulative and/or simultaneous impact of multi-stress factors on marine and coastal ecosystems<br>• Link between marine coastal ecosystem change and occurrence of harmful algae blooms and dead zones/hypoxia<br>• Impact of contaminants of emerging concern (e.g. from micro-plastics, pharmaceuticals, personal care products, ethylene dichloride)<br>• Impact of nanomaterials on biota<br>• Linking terrestrial and coastal/marine policies to address pollution from land-based sources<br>• Impacts of underwater noise<br>• Depollution techniques and pollution preventive measures<br>• Pathways and fate of contaminants (especially, POPS, heavy metals and microplastics) into marine environments<br>• Ecological threshold of contaminants or water quality standards for ecosystem functioning and stability<br>• Understanding the extent and effects of alien invasive species (lags behind that for terrestrial invasive species)<br>• Economic assessment of impact of alien invasive species on coastal and marine environment, including deep and open oceans<br>• Effectiveness of eradication programs for alien invasive species<br>• Cascading effects of alien invasive species on marine food web and ecosystem functioning and stability |

| Marine pollution from marine and land-based sources (II) | | |
|---|---|---|
| Implications for Human Well-being | Illustrative scientific reports* | Further research areas suggested by contributing experts: |
| • (Increase of) health hazards such as:<br>- freshwater pollution;<br>- human intoxication/poisoning (e.g. toxins in fish and shellfish);<br>- accumulation of plastic nanoparticles in food web<br>- degradation of bathing water quality;<br>- skin diseases from exposure;<br>• Displacement of local communities (by cases of pollution which make economic activities inviable for years or decades)<br>• Decrease in attractiveness of destination for tourists – decrease in related job opportunities and revenues<br>• Decreased wild food fish availability - significant loss of food supply and income<br>• Decrease in coastal real estate value (e.g. due to unhealthy water quality and/or degraded landscape/seascapes)<br>• Decreased seed and feed availability for aquaculture as alternative livelihood - decreased productivity undermining food security<br>• Introduction of alien invasive species reduces or potentially causes disappearance of commercial or food-important marine resources<br>• Increased spread of diseases as a result of harmful algae blooms worsened by alien invasive species<br>• Direct and indirect impacts on coastal transport infrastructure, services and operations (ports and other assets), including fouling of marine infrastructure caused by alien invasive species<br>• Threat to navigation and safety at sea through abandoned, lost and otherwise discarded fishing gear (ALDFG) | • UN World Ocean Assessment (2015)[183]<br>• UNEP (2013). Regional Plan on Management of Marine Litter in the Mediterranean.<br>• Ngah et al. (2012). Marine pollution trend analysis of tourism beach in Peninsular Malaysia.<br>• Hester and Harrison (2011). Marine Pollution and Human Health.<br>• Corcoran et al. (2010). Sick Water? The central role of wastewater management in sustainable development.<br>• Mouat et al. (2010). Economic Impacts of Marine Litter. | • More marine ecosystem evaluation studies<br>• Quantification of socioeconomic impacts<br>• Economic evaluation of waste water treatment plants<br>• Aggregate effects of marine pollution on food quality and health<br>• Health implications of microplastic ingestion<br>• More studies about successful participatory coastal rehabilitation projects and on ways to replicate them<br>• Effects of visual marine pollution on destination choice made by the tourists<br>• Agricultural development and pollution from land-based sources and activities (LBS)<br>• Impact of contaminants on human health<br>• Impacts of harmful algal blooms on human health<br>• Externalities resulting from port activities (air pollution, noise, land use, dredging costs and impact on environment, etc.)<br>• Socio-economic impact of specific alien invasive species invasions<br>• Potential use of alien invasive species for livelihoods (e.g. lionfish) |
| **Unsustainable extraction of marine resources (I)** | | |
| Impact on Oceans, Seas and Marine Resources | Illustrative scientific reports* | Further research areas suggested by contributing experts: |
| • Decline and loss of marine species – threatening marine food web and overall ecosystem functioning and stability<br>• Changes in ecological interactions between species with unpredictable consequences for food web and ecosystem functioning and stability<br>• Capturing and mortality of non-target species (by-catch), including endangered, threatened and protected<br>• Damage and/or destruction of critical and vulnerable fishing grounds and marine and coastal habitats<br>• Degradation of water quality | • UN World Ocean Assessment (2015)[184]<br>• FAO (2014). The State of World Fisheries and Aquaculture - Opportunities and Challenges.<br>• Agnew et al. (2009). Estimating the Worldwide Extent of Illegal Fishing. | • Environmental impacts of deep sea mining and adequacy of environmental management approaches and regulatory regimes<br>• Better quantification of spatial extent of bottom trawling (and uses of other gears such as gill nets)<br>• Rehabilitation of depleted invertebrate wild stock<br>• Research on properties that make marine ecosystems resilient (or lose resilience) |

| Unsustainable extraction of marine resources (II) | | |
|---|---|---|
| Implications for Human Well-being | Illustrative scientific reports* | Further research areas suggested by contributing experts: |
| • Decreased wild food fish availability - significant loss of food supply and income<br>• Decrease in attractiveness of destination for tourists – decrease in related job opportunities and revenues<br>• Possible displacement of local communities by abusive or unregulated extraction of resources (e.g. reduced fishing opportunities generating internal or external migration flows)<br>• Unacceptable working conditions affecting fishers and fish workers; child labor<br>• Decreased seed and feed availability for aquaculture as alternative livelihood - decreased productivity undermining food security | • UN World Ocean Assessment (2015)[185]<br>• High-level Panel of Experts on Food Security and Nutrition (2014). Sustainable fisheries and aquaculture for food security and nutrition.<br>• UNCTAD (2014). The Oceans Economy: Opportunities and Challenges for Small Island Developing States.<br>• Srinivasan et al. (2012). Global fisheries losses at the exclusive economic zone level, 1950 to present. | • Systematic assessment of poverty dimensions associated with livelihoods in fisheries and aquaculture<br>• Estimated value of fisheries beyond value of fish resources or harvest sector<br>• Impact of IUU fishing on local communities (e.g. significant loss of income); link between IUU fishing and unacceptable working conditions<br>• Identification of most suitable options for sustainable fish farming, especially in developing countries<br>• Social (employment) versus economic (profit) trade-offs in uses of living marine resources<br>• Costs and benefits of shift to more sustainable practices |
| **Physical alterations and destruction of marine and coastal habitats and landscapes (I)** | | |
| Impact on Oceans, Seas and Marine Resources | Illustrative scientific reports* | Further research areas suggested by contributing experts: |
| • Decline and loss of marine species<br>• Destruction, displacement or alteration of marine and coastal wildlife habitats, including nesting and spawning areas and nursery grounds<br>• Impact on ecosystem functioning and stability<br>• Impact on shorelines and coastal stability; coastal erosion<br>• Alteration of microbial structure and biogeochemistry, including greenhouse gas cycles | • United Nations World Ocean Assessment (2015)[186]<br>• Liu and Su (2015). Vulnerability of Nearshore Ecosystems from Rapid Intensive Coastal Development.<br>• Halpern et al. (2008). A global map of human impact on marine ecosystems. | • Evaluation and mapping (in multiple terms) of coastal ecosystems<br>• Impact of underwater noise<br>• Systematic assessment of deep-sea ecosystems<br>• Specific impacts of physical alterations on marine and coastal ecosystems and resilience of affected ecosystems<br>• Ecological effects of emerging activities, such as ocean geo-engineering (e.g. CO2 injection, ocean fertilization), renewable energy and open ocean aquaculture<br>• Study tourism operators and land developers' level of involvement and concern in nature conservation<br>• Release of carbon from coastal ecosystems by physical alteration and land use change<br>• Impacts of eroded sand from beach nourishment on benthic communities |
| **Physical alterations and destruction of marine and coastal habitats and landscapes (II)** | | |
| Implications for Human Well-being | Illustrative scientific reports* | Further research areas suggested by contributing experts: |
| • Decreased wild food fish availability - threatening food security<br>• Increased vulnerability of local communities due to undermined natural protection barriers and degradation and destruction of coastal settlements<br>• Reduced attractiveness of destination and quality of tourist experience –reduced sources of employment and revenue<br>• Loss of access to marine and coastal resources for livelihoods and recreation (e.g. hotel resorts not allowing passage to beach) - affecting food security and income (small-scale fisheries)<br>• Decreased seed and feed availability for aquaculture as alternative livelihood<br>• Displacement of communities | • Burke et al. (2012). Reefs at Risk Revisited in the Coral Triangle. World Resources Institute<br>• Burke et al. (2011). Reefs at risk revisited. World Resources Institute.<br>• Edwards (2009). Measuring the Recreational Value of Changes in Coral Reef Ecosystem Quality in Jamaica: The Application of Two Stated Preference Methods.<br>• White et al. (2000). Philippine Coral Reefs under Threat: The Economic Losses Caused by Reef Destruction. | • Evaluation of impacts of physical alterations on marine and coastal ecosystems and subsequent effects on communities<br>• Adaptive capacity of coastal communities<br>• Development of ecosystem-based solutions for coastal defence and "hybrid-engineering"<br>• Cost benefit analysis of coastal development |

**Further illustrative scientific reports are available in Annex I.*[187]

While the scientific coverage of the different threats and their impacts varies, contributing experts strongly believe that oceans, seas and marine resources are severely affected, with negative implications for human well-being. They found that the scientific coverage of the impact of marine- and land-based human activities on oceans, seas and marine resources is often better documented than the implications of the deterioration of oceans, seas and marine resources for human well-being. There is a therefore a need to improve further the scientific coverage of socio-economic impacts of threats affecting the nexus.

Different human activities and natural processes affect marine and coastal ecosystems simultaneously, interacting and leading to cumulative effects. Contributing experts point out that a better understanding of cumulative and interactive effects of different human activities is needed to develop more effective integrated management and is vital to properly evaluate the consequences of human activities, especially of emerging activities like geo-engineering or industrial development in extreme areas (e.g. Arctic and deep-water). According to the Assessment of Assessments, science has however limited ability to detect both indirect and cumulative effects as they can be non-linear and manifest only after long time delays, which makes them very difficult to predict.[188]

### 3.3. Illustrative case studies – the need for an integrated approach when dealing with the nexus

Table 3-4 contains a number of case studies illustrating how regions and countries have been addressing threats affecting the nexus, with benefits for both human communities and the environment (see also Annex I). They underline the connection between ecosystem integrity and societal well-being, and the need for integrated approaches. The majority of case studies reviewed focuses on conservation and protection measures targeted at a particular threat. Few aim to address several threats simultaneously. Apart from the creation of marine protected areas and other conservation measures, the creation of sustainable livelihoods, the use of policy regulations as well as capacity-building, education and awareness-raising measures are some of the forms of interventions used. The quantitative evaluation of the impacts of respective projects, in particular as they relate to human well-being, is often not existent. Some of the lessons learned and best practices of existing case studies could possibly be useful for and adapted to other countries and regions of the world.

**Table 3-4. Selected regional and local case studies of addressing threats affecting the nexus***

| Case study | Challenges faced | Measures undertaken | Impact on Oceans, Seas and Marine Resources | Implications for Human well-being |
|---|---|---|---|---|
| **Regional level** | | | | |
| **Marine litter, regional seas in Europe**[189] | Mortality of marine species (e.g., through entanglement and ingestion); loss of ecosystem functioning and services; marine habitat alteration, degradation, or destruction | Prevention through awareness-raising/market-based instruments (e.g. plastic bag reduction by banning or taxing); Regional Action Plan for the Management of Marine Litter, including adequate waste reducing/reusing/ recycling measures; extended producer responsibility; establishment of voluntary agreements with retailers and supermarkets; clean-up of litter | • Reduced risk of environmental impacts due to reduced marine litter such as plastic items (e.g. significant reduction of plastic bag usage) | • Maintenance of fish catch and tourism revenue<br>• Revenue through levies and taxes<br>• Reduced marine litter removal activities and damage to nautical equipment |
| **Marine ecosystem conservation: preserving the wealth of natural capital, Mediterranean region**[190] | Biodiversity in region severely at risk: 19% of all species threatened with extinction and 1 % already extinct at regional level | Network of Marine Protected Areas (170 MPAs; 2 UNESCO World Heritage Sites and 5 Biosphere Reserves); MedPan as coordination framework for conservation activities; changes of unsustainable fisheries practices (catch monitoring etc.) | • Increase in diversity, abundance, and average size of exploited species<br>• Ecosystems rebuilt<br>• Preservation of ecological processes and coastal and marine habitat | • Support of economically valuable activities (e.g., tourism, small scale sustainable fisheries)<br>• Maintenance of associated cultural values |
| **Economic, social and environmental benefits from sustainable** | Over-exploitation of the region's oceanic fishery resources | Regional Strategic Action Programme (SAP) for International Waters of Pacific Islands to integrate | • Catches of bigeye, albacore, and yellow fin tuna at or below maximum sustainable | • Increase in fish catches by a factor of 2<br>• Number of people employed by local |

| | | | | |
|---|---|---|---|---|
| **management of tuna fisheries: The GEF/UNDP Pacific Islands Oceanic Fisheries Management Project, Western Pacific**[191] | | national and regional sustainable development priorities; Sustainable management of regional/ transboundary fish stocks | yield (stocks at lower risk of being overfished)<br>• Decreased discarding of non-target species – rates for longliners targeting albacore, bigeye, and yellowfin tuna have decreased from an average of 12.4, 3.5 and 3.85% respectively to nearly 0% for all species. Similar decreases were seen for purse seine fishery. | inshore tuna processing facilities doubled<br>• Increase in fishery exports by US$ 134 million, representing a third of the region's overall exports<br>• Increase in foreign fishing access fees by 24% |
| **Nutrient pollution reduction, Danube/Black Sea Basin**[192] | Fertilisers used in agriculture leading to nutrient pollution (nitrogen, phosphorus) from farm run-off plus increase in "point sources" of pollution from poorly or untreated wastewater and large scale livestock farms (manure) – creation of hypoxic/low oxygen conditions, a number of species and benthic ecosystems disappeared, economic losses | Danube and Black Sea Strategic Action Programmes- reform of policies, legislation and institutions related to reducing nutrient pollution in the basin, including adoption of best agricultural practices for manure management and fertiliser application, phase out of phosphorus-containing detergents, promotion of industrial cleaner production etc.; capacity-building and partnerships | • Substantial reduction in nutrient pollution<br>• Restoration of good water quality<br>• Decrease of biomass of phytoplankton<br>• Return of key benthic "phylophora" habitat<br>• Return of many species considered locally extinct | • Restoration and maintenance of environmental and socioeconomic benefits for nearly 160 million residents of the basin |
| **Local level** | | | | |
| **Development of mariculture activities as an alternative livelihood option for coastal communities: Milkfish farming in Kilwa and Mtwara districts, Republic of Tanzania**[193] | Increased overfishing and use of destructive fishing practices (e.g. dynamite fishing) resulting in decline of fish quality and quantity | Conservation measures, including marine parks, reserves and protected areas; development of mariculture activities as alternative livelihood | • Protection of oceans and marine and coastal biodiversity<br>• Restoration and conservation of wild fishery | • Welfare gains (e.g. improved dietary intake, better capacity to meet household food needs, ability to purchase new assets, ability to meet student requirements for school)<br>• Improved food security (from two to three meals a day)<br>• Enhancement of investments and savings |
| **Community-based green sea turtle conservation, The Comoros**[194] | Turtle poaching leading to conflicts between turtle poachers and community of Itsamia (willing to address issue of poaching) | Education of entire community and awareness raising; Beach patrols, monitoring of nesting sites, involvement of police, confiscation of poachers' boats; Additional conservation efforts, incl. implementing and enforcing fishing regulations, cleaning of beaches and collection of household waste | • Significant reduction of turtle poaching<br>• Maintenance of large fish populations<br>• Increase in fish biomass from 16 to 32 kg/100m2 | • Creation of successful eco-tourism generating income and jobs<br>• Poverty eradication benefits (e.g. health initiatives and acquisition of aid to subsidize local doctor and hospital visits)<br>• Sustainability of fishing opportunities allows fishers to earn livelihood to meet their needs |
| **Ban of queen conch harvesting by fisheries: A recent conservation co-** | Conch fishery decline to unsustainable levels due to unsustainable and illegal fishing | Conservation and management measures, including designation of biosphere reserve (in | • Increased health and quality of marine flora and fauna<br>• Restoration and | • Lobster and deep-sea snapper harvests provide a new source of income and seafood for local |

| | | | | |
|---|---|---|---|---|
| **management initiative in Banco Chinchoro, Quintana Roo, Mexico**[195] | | consultation with local communities), no-take zones and conch harvesting bans; establishment of alternative livelihoods | conservation of conch fishery | communities<br>• Increased emphasis on eco- tourism leading to significant improvements in community livelihoods |
| **Ecosystem Health Report Card for Managing Chilika Lake of Odisha State: a collaborative approach, India**[196] | Deterioration of the lake's ecosystem due to natural processes and human activities | Restoration strategy based on ecosystem approach; development of "Ecosystem Health Report Card" to diagnose problems and identify intervention priorities; messages used in communication strategy to engage stakeholders for sustainable management of ecosystem | • Eight-fold increase in annual fish and prawn landings<br>• Decrease of alien invasive species<br>• Protection of marine environment from land-based activities | • Increase in fish catch<br>• Increase of monthly family income of fishermen<br>• Development of community-based ecotourism as alternative livelihood |
| **Linking Conservation and Livelihoods in the Oracabessa Bay Fish Sanctuary, Jamaica**[197] | Severe degradation of marine ecosystems and high loss of biodiversity - declining fish catch and challenges for local tourism industry | 2-phase project to preserve the marine ecosystem and increase biodiversity and species population; creation of a no-fishing zone protecting critical breeding areas and fish habitat; improve surveillance and monitoring of fish, turtle, and coral populations within sanctuary; strengthen community capacity to manage its marine resources; removal of debris from beaches | • Increase in coral reefs by 153%, fish density by 272%, fish size by 16%, fish biomass by 564%<br>• Reduction of algae by 43%<br>• Several species made a comeback or recovered<br>• Improved sea turtle nesting conditions and hatching rates | • Generation of alternative income opportunities through the project (fishermen re-employed as coral gardeners and tour guides)<br>• Income from ecotourism and collection/sale of nutrient-rich debris<br>• Involvement of youth in project elaboration to ensure future marine conservation |

**Further illustrative case studies are available in Annex I.*[198]

A number of methods can be used to assess the socio-economic impacts of oceans-related conservation measures and policies and should ideally be applied before implementation: (1) project appraisal and evaluation methods, including some mainstream methods such as cost-benefit analysis, and other less frequently used but promising methods such as social return on investment or multi-criteria analysis; (2) bio-economic models; (3) indicator systems; and (4) social surveys. As an example, the Marine Institute of Plymouth University recently developed the Integrated Marine Protected Areas Socio-Economic Monitoring (IMPASEM) framework to monitor and assess the socioeconomic effects of marine protected areas within the PANACHE project.[199]

Asked whether overall the sum of existing projects and programmes at various geographical levels "added up" to a more sustainable management of oceans, seas and marine resources and an increase in human well-being, contributing experts note that, despite a multitude of different programs and initiatives, there seems to be a lack of common vision and integration among them, which can lead to duplications, overlaps, gaps and possibly conflicting actions by different actors. The quantitative and qualitative level of projects and programmes across various geographical regions varies. Some programs and projects are not necessarily commensurate with the needs on the ground. Contributing experts find that that projects and programmes are often able to result in more sustainable oceans management at the local and community scales, but need to be scaled up to the national and regional level. A challenge perceived is the lack of sufficient resources – human, financial, and knowledge—coupled with a lack of political will to tackle issues at the scale that is required. The implementation of national action plans, strategies and policies aimed at sustainable development is seen as being important to support ongoing efforts.

### 3.4. Towards an integrated approach when dealing with the oceans, seas, marine resources and human well-being nexus

Oceans, seas and marine resources support the human well-being of all people by contributing to poverty eradication, food security, the creation of sustainable livelihoods and jobs, human health and protection from natural disasters. They are the primary regulator of the global climate and an important sink for greenhouse gases, while also providing humans with water and oxygen. However, marine- and land-based human activities often threaten ecosystem integrity and hamper the provision of ecosystem services crucial to humans and sustainable development.

Good governance, an enabling environment, sustainable land- and marine-based human activities, and adequate measures will be required to reduce the negative anthropogenic impacts on the marine environment. Projects and measures should ideally be designed and implemented in an integrated, cross-sectoral and cross-scale manner, in line with the ecosystem approach and involving all stakeholders. Terrestrial and marine/coastal governance should be linked, specifically addressing the impact of land-based activities on marine and coastal environments (e.g. marine pollution).

An ecosystem approach to ocean management is required, which considers the entire ecosystem, including humans, in an integrated manner and takes into account the cumulative impacts of different sectors and human activities. The United Nations General Assembly noted that such approaches should be "focused on managing human activities in order to maintain and, where needed, restore ecosystem health to sustain goods and environmental services, provide social and economic benefits for food security, sustain livelihoods in support of international development goals" … "and conserve marine biodiversity".[200] Marine spatial planning (MSP) and integrated coastal zone management (ICZM) are some of the management tools that play an important role, particularly in relation to managing conflicts of use. A multitude of measures can be implemented to restore, conserve and protect oceans, seas and marine resources such as the creation of marine protected areas and reserves. In this regard, it should be kept in mind that sustainable alternative livelihood opportunities might have to be created simultaneously so as not to undermine the livelihoods of local populations. Policy regulations and/or incentives might be necessary to change the behaviour of stakeholders and encourage their engagement in conservation and protection measures.

High-quality data can support effective ecosystem management (see as an example Box 3-5). In support of the World Ocean Assessment, the Gramed database[201] is expected to be updated to ensure that a single portal will enable those interested to identify the information on which the first World Ocean Assessment is based and help them to access it.[202] In the past, scientific assessments contributed solid foundations in terms of information systems, for example the Census of Marine Life[203] with the Ocean Biogeographic Information System (OBIS)[204]. According to contributing experts, comprehensive databases, first at the country and then at the regional level, are required. Research institutions within each region should seek to work collaboratively to ensure that research efforts are not duplicated, and that limited resources are efficiently utilized. The observation and monitoring of marine and coastal ecosystems are important to identify changes over time, assess the effectiveness of implemented measures and policies and allow decision-makers to develop appropriate and timely responses. The Global Ocean Observing System (GOOS) is a good example of a system for observations, modelling and analysis of marine and ocean variables to support marine science, assessment of change and operational ocean services worldwide. Its three advisory bodies[205] supply scientific studies and expertise. One of them, the newly created Biology and Ecosystems Panel, will, among others, identify major scientific and societal challenges that require sustained ocean biology and ecosystem variable observations.[206]

**Box 3-5. Space technology data for ecosystem management**

Space technology and other spatial applications can supplement in-situ observations and provide valuable near-real time observations of physical, chemical and some biological parameters at the sea surface and help overcome some of the issues caused by the trans-boundary nature of the oceans. Several key ocean parameters can be obtained in this manner (e.g. ocean bottom character, contaminants, heat flux, ice distribution, ocean colour, salinity, sea level, stream flow, surface currents, surface waves, temperature, wind speed and direction, and upper layer zooplankton abundance). Space technology can also support the management of biodiversity and wildlife, for example by tracking tagged animals. Other ways of using satellite data are being explored, including for tracking illegal, unregulated and unreported fishing.[207]

The illustrative case studies presented in Section 3.3 confirm the close inter-linkages between oceans, seas, marine resources and human well-being and demonstrate that actions impacting one area of the nexus may also have an effect on the other areas. This aligns with the concept of a network of SDGs with a multitude of interactions and synergies (see chapter 2). In this context, future scientific research needs to be integrative and cross-sectoral and further "system or cluster thinking" approaches.

Scientific information combined with relevant knowledge from experiences in implementing concrete projects can guide policy-making and activities. A collection of relevant scientific reports organized by topics, as presented in Annex II of this chapter, could be useful. In this context, the continuation and update of the Gramed database[208] could be considered. The scientific coverage of socio-economic aspects of the nexus and threats affecting it needs to be improved. Enhanced trans-/multidisciplinary research is

required, with natural and social scientists working together with holders of relevant traditional and experiential knowledge, to better understand the nature of the complex interactions between humans and marine and coastal ecosystems. More research towards valuing ecosystem services, which might in turn encourage the protection, conservation and more sustainable use of oceans, seas and marine resources, is required.

Contributing experts indicate a need to strengthen the communication between scientists, practitioners, decision-makers and the wider public. All stakeholders need to be engaged in a more effective and systematic manner. Institutional barriers to an effective science-policy interface should be eliminated, in order to enable closer collaboration among researchers, practitioners and government officials. Research could sometimes be more demand-driven and focused on policy-relevant information rather than on knowledge and research gaps. Research findings could be disseminated to the wider public for the purpose of education and increased awareness. The effectiveness of environmental education and engagement programmes with respect to changing the behaviours of resource users and decision makers could be analysed.

Human well-being cannot be achieved without the protection and conservation of the Earth's ecosystem. To maintain the quality of life that the oceans have provided to humankind, a change will be required in how humans view, manage and use oceans, seas and marine resources. Science can play an important supporting role in this regard.

**Annex 1 (Extended versions of Table 3-1, 3-3, 3-4)**

*Given its large size, Annex 1, containing extended versions of Tables 3-1, 3-3, 3-4 is available on the DESA-administered Sustainable Development Knowledge Platform under: https://sustainabledevelopment.un.org/globalsdreport/2015.*