Inputs to Secretary General's Annual Report to the General Assembly on the Ocean and Law of the Sea
Part I: "The Effects of Climate Change on Oceans"

United Nations Environment Programme

Executive Summary

Climate change has long been a strategic focuses of the United Nations Environment Programme (UNEP). In 1988, UNEP together with the World Meteorological Organization established the Intergovernmental Panel on Climate Change (known as IPCC). The Panel has been providing the world with a clear scientific view on the current state of knowledge in climate change.

Climate change has social, economic and environmental impacts. Marine and coastal ecosystems are predicted to be negatively affected by climate change. The Panel has reported climate change impact on oceans including ocean warming, sea-level rise, ocean acidification and reduction in sea ice. These changes will affect marine life, which underpin the provision of ecosystem services to humans. Coastal dwellers depending on these ecosystem services for their life, including fisheries and coastal tourism, will be largely affected.

To address and adapt to climate change, UNEP is providing support to countries in applying ecosystem-based adaptation. This approach uses the conservation, sustainable management and restoration of ecosystems to adapt to the adverse effects of climate change. Pilot activities have been implemented in several Small Island Developing States. UNEP is also implementing a project to enhance the current knowledge of carbon storage and sequestration and ecosystem services provided by blue forests ecosystems, namely mangroves, seagrass and salt marshes. By doing so, the project aims to contribute to ocean-based adaptation and mitigation.

The Regional Seas programmes also identified climate change as one of the four strategic themes to be addressed during the 2017-2021 period. Several Regional Seas programmes have already developed regional strategy to address climate change. Under the Barcelona Convention, for example, Contracting Parties adopted a Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas.

Through the Regional Seas Indicators Working Group, the Regional Seas programmes adopted 22 ecosystem-based indicators including one related to ocean acidification. It is expected that regional monitoring programms based on indicators will contribute to increasing the understanding of climate change impact on oceans.

Further research and awareness raising activities are needed to better address climate change impact on oceans. UNEP will launch a global campaign on coral reef to draw attention to the importance of coral reef and the spread of coral bleaching in the context of climate change. It is hoped that the campaign will catalyze actions across the world at local, regional and global levels.

Introduction

Since its establishment in 1972, conservation and sustainable management of oceans and seas have been at the heart of the United Nations Environment Programme (UNEP). The Governing Council of UNEP and subsequently the United Nations Environment Assembly[1] have repeatedly adopted decisions and resolutions to address degradation of marine and coastal ecosystems.

At the Second Session of the United Nations Environment Assembly held in May 2016, Member States adopted the medium term strategy for the period 2018-2021. Through the document, Member States recognized that climate change is one of the priority areas that UNEP will put strategic focus in the coming years. Climate change is expected to have major and unprecedented social, economic and environmental impacts.

The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) showed that climate change is putting significant pressures on ecosystems and oceans are not an exception. The panel also reported climate change impact on oceans including ocean warming, sea-level rise, reduction in sea ice, and ocean acidification.

Noting the impact of climate change on the oceans, Member States demonstrated that they are *[G]gravely concerned about threats to the health of our oceans, coastal areas, wetlands and islands, as reflected, inter alia, in the first global integrated marine assessment (World Ocean Assessment I) of the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects, acknowledged in United Nations General Assembly resolution 70/235, the fourth Global Biodiversity Outlook report and chapter 30 of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change and about their probable increase in the foreseeable future*"[2]. Member States thus requested the Executive Director of UNEP to "*contribute to the implementation of pre-2020 global efforts to address the challenge of climate change*" through resolution 2/6 Supporting the Paris Agreement of the United Nations Environment Assembly.

In this context, the eighteenth meeting of the Informal Consultative Process will focus its discussion on the topic entitled "The effects of climate change on oceans". This report summarizes the ongoing activities under the coordination of UNEP to provide inputs to the Secretary-General's report.

1. Key interactions between oceans and climate change

1.1 Ocean warming

A trend in increasing sea surface has been observed since the beginning of the 20th century, and the rate of heating is accelerating. Two thirds of the heat absorbed by the ocean is in the upper ocean (<c 700m), and the remaining third absorbed in the deep ocean. It is known that there is relatively greater ocean warming in the southern hemisphere than in the northern.

This absorption of heat in the ocean has protected the world from more extreme climate changes than has already been observed. However, this comes at the cost of significant changes in ocean ecosystems, and consequently ecosystem services which people depend on.

[1] At the United Nations Conference on Sustainable Development (Rio +20) in 2012, Member States upgraded UNEP and replace the Governing Council with the United Nations Environment Assembly with the universal membership of the UN Member States. This allowed wider participation of UN member states in decision making on the global environment agenda.

[2] Resolution 2/10 Oceans and seas of the United Nations Environment Assembly

2. Effects of climate change on the oceans – environmental, social and economic

2.1 Ocean warming

2.1.1.1 Environmental effects on marine ecosystems and biodiversity

An increase of 0.7°C in global mean sea surface temperature has been observed over the last century, with effects on many temperature-dependent biological processes. There is overwhelming evidence that most effects of ocean warming on marine environments will likely be negative. Coral bleaching is among the most visible and destructive impacts, which is projected to become more frequent and more severe with climate change.

Ocean warming stands to significantly alter food webs at the global scale and is predicted to reduce ocean primary productivity. It is a contributing factor to increasing areas of oxygen depletion worldwide, with impacts on biodiversity and functioning of ecosystems. Oxygen solubility is reduced in warmer water, and with surface warming the water column becomes more stratified, leading to reduced penetration of oxygen into deeper water. Deep sea ecosystems may be impacted by reduced transport of carbon to the deep ocean, but knowledge remains limited.

Warming will lead to poleward shifts in the distribution of many plankton and fish species, and some fish species have already shifted their range hundreds of kilometers. Changed seasonal timing of plankton productivity also has implications for many fish species and fishery productivity. Tropical and polar fishes are more sensitive to ocean warming, and the tropics are likely hotspots of ocean warming-driven local extinctions.

Increased virulence of pathogens is likely to significantly affect marine species and ecosystems, including coral reefs, where reduced reproduction and increased coral mortality will reduce habitat quality for reef-dwelling species including fish.

Coral reefs are one of the most vulnerable marine ecosystems to ocean warming, and they will be severely impacted through increased coral bleaching. Warming has also been linked to reduced calcification rates. The frequency of bleaching-level temperature stress increased threefold between the late 1980s and the early 2010s[3]. Between 2014 and 2016, the world witnessed the longest global bleaching event ever recorded. This killed coral on an unprecedented scale in many locations, affecting, for example, 90 per cent of coral on the Great Barrier Reef and killing more than 20 per cent of the reef's coral. This trend is predicted to continue. Under a business as usual scenario, severe bleaching will occur every year on 99% of the world's coral reefs within this century. Temperature stress sufficient to trigger severe bleaching may become an annual phenomenon for the majority of the reefs in the world as early as the 2040s. There is, however, significant local-scale variation in the predicted onset of annual severe bleaching, and protection of relative climate refugia combined with ambitious mitigation offer some hope[4].

Primary production of plants may rise with ocean warming. However, 10-15% of mangroves area may be lost due to climate change by 2100[5]. Warming may in some areas lead to mangroves displacing tidal marsh plants. Seagrasses will also face increasing stress from a higher frequency and intensity of temperature maxima. This will include greater mortality of seagrass especially where warming exacerbates eutrophication.

In summary, warming above 2°C, which may happen by mid-century, will have a significant effect on marine biodiversity, affecting more than half and potentially two thirds of the global ocean.

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[3] Heron et al 2016

[4] Van Hooidonk et al 2016

[5] It should be noted that, at the moment, logging and other deforestation of mangrove is a much more significant source of mangrove loss

2.1.1.2 Social and economic effects on marine ecosystems and biodiversity

The most significant and immediate social and economic impacts of ocean warming will be felt by the people and industries most directly dependent on living marine resources. This includes many of the predominantly poor coastal dwellers that depend on small scale fisheries for protein and income, companies in the fishery value chain and marine/coastal tourism, and many living in Small Island Developing States. For example, coral bleaching, which threatens all the world's coral reefs and their many ecosystem services, will impact hundreds of millions of coastal dwellers in over 100 countries with reefs.

The climatological effects of ocean warming are also likely to carry significant social and economic risk. Cyclones and hurricanes are likely to become more frequent and stronger, and may occur over larger areas as the 'cyclone belt' which latitudinally expands.

Changes in climate over land will lead to landslides e.g. where rainfall increases, or to increased risk of forest fires and thereby higher air pollution where rainfall decreases. Warming will also have a direct impact on crop productivity, with e.g. maize yields sensitive to increasing temperature.

The costs of ocean warming impacts on human society are likely to increase, as a result of direct impacts on people and infrastructure from severe weather events as well as effects on economic sectors, employment and social wellbeing as a result of lost ecosystem services. In addition, warming will have increasingly severe implications in terms of malnutrition as well as human migration in some areas.

2.1.2 Effects on marine species

2.1.2.1 Environmental

Habitat loss as described above will have significant implications for all species dependent on these habitats. Declines in sea turtle populations have already been observed. All species of marine turtles will increasingly be impacted by changes in beach/nesting habitat as well as through the various ecosystem impacts on a warming ocean.

Seabirds are vulnerable mainly to the effects of ocean warming on productivity. Evidence is increasing of impacts on marine mammals, such as shifts in distribution and migration as well as reproductive success rate. Some mammals will increasingly face reduced habitat quality and access.

Ocean warming will lead to changes in the distribution and migration of commercially important fish as well as fishery productivity, and the maximum body size of many fishes may also decrease. Tropical and polar fishes are known to be more sensitive to ocean warming, but there is higher uncertainty about the impacts on pelagic fish such as tuna.

2.1.2.2 Social and economic

Direct social and economic implications of effects on marine species will be felt in communities and industries disproportionately dependent on a given species or species group. For example, costs associated with nature tourism such as bird or whale watching may go up where species loss or population shifts necessitates longer journeys. Such industries may locally collapse in their entirety, leading to locally significant losses of jobs and income.

Changed productivity patterns, fish distribution and migration patterns will change fishing grounds, in many instances leading to higher cost and redistribution of benefits arising from fisheries. Abrupt and fundamental shifts in ecosystems, which are challenging to predict and to manage, may also lead to reduced catch rates and loss of entire fisheries. Further, the effectiveness of many commonly applied marine management and conservation efforts, such as Marine Protected Areas as stock-based management of fisheries management, may be reduced.

Warming will also impact the aquaculture industry. While it will lead to faster growth rates in some species and in some locations, or offer opportunities to introduce new species in aquaculture, thermal stress will also cause a number of problems for many currently cultured species. There is a likelihood of increased contamination of shellfish as a result of more phytoplankton blooms, and also higher loss to diseases and parasites. This will necessitate significant emphasis on adaptation both in the fisheries and aquaculture industries.

2.1.3 Sea-level rise

2.1.3.1 Environmental

The environmental impacts of sea-level rise will be widespread and significant, including permanent inundation of land, increased flooding during storms and extreme weather events, and increased erosion especially on soft coasts. Tidal wetland area will decrease where inland migration is prevented by geological formations or human infrastructure. However, questions remain regarding the ability of ecosystems to vertically grow at a pace matching sea level rise. Impacts on mangroves will be significant, with mortality and loss on the seaward margin, and diebacks are already seen in many mangroves not able to keep up with sea-level rise. Mangroves with a low tidal range are likely to be most vulnerable.

While a healthy coral reef can grow vertically in response to sea level changes, reefs have generally not been able to keep pace with rapid sea-level rise. Projected sea level rise may exceed the ability of most reefs to grow, not least in view of the fact that reef growth will be increasingly impeded by warming and ocean acidification. Increased shoreline erosion will also lead to increased sedimentation and turbidity on many reefs, thereby reducing their growth further. Because of this, many reefs will be unable to keep pace with sea-level rise and will either change fundamentally or cease to exist.

The coastal ecosystem impact of sea level rise has significant direct implications for species dependent on these ecosystems. This includes both terrestrial and marine wildlife. Loss of ecosystems will also diminish the services they provide, such as loss of coastal protection.

2.1.3.2 Social and economic

The social and economic costs of sea level rise may be severe, including as a result of salt water intrusion into aquifers, coastal erosion and inundation, and increased flooding from storm surges. Some coral islands and atolls may be entirely lost. Sea level rise will also affect coastal aquaculture, making infrastructure more vulnerable and or making areas unsuitable for certain species/cultures.

Implications for human communities include increased water and food insecurity in many areas, and greater vulnerability to and loss from flooding. Sea level rise will thus necessitate increased efforts to maintain coastal infrastructure, or assuming the costs of forfeiting infrastructure in vulnerable areas. It will force coastal communities and industries to relocate partially or entirely, with attendant challenges in relation to land access, land rights as well as sea-use rights. Sea level rise will eventually trigger large scale human migration or resettlement, especially in low lying and particularly vulnerable areas.

2.1.4 Melting ice in Polar regions

The fifth Global Environmental Outlook (GEO-5) described that small glaciers and ice caps had significant loss over the 20th century and this trend will likely to continue in the future. Melting Greenland and Antarctic ice sheets have become the biggest contributors to sea level rise and will continue to be a key driver for future sea level rise.

Noting the importance of the issue, Member Stated encouraged "*the United Nations Environment Programme to provide scientific support, in cooperation with relevant organizations, programmes and forums, to increase*

understanding of –and thus help in avoiding – abrupt, accelerating or irreversible environmental changes with potentially significant global consequences –for example, thawing of the permafrost of the seabed and melting of sea ice and glaciers" at the Second Session of the United Nations Environment Assembly[6].

2.1.4 Extreme weather events

UNEP implemented the Transboundary Water Assessment Programme, funded by the Global Environment Facility. The programme concluded that climate-related extreme events and changing ecosystem states will put further burdens on coastal communities. It will be important for Member States to prepare and adapt to the changes in weather pattern.

UNEP together with the United Nations Development Programme (UNDP) has formed the UNEP-UNDP Poverty and Environment Initiative to promote poverty reduction thorough sustainable natural resource management. The Initiative supports countries to achieve sustainable development by integrating ecological, climate and fairness concerns into national, subnational and sectoral economic decision making and planning process. The partnership, for example, has been providing assistance to the Government of Bangladesh in responding to extreme climate risks and disasters and planning for adaptation of a sustainable development pathway.

2.2 Carbon dioxide flux and ocean acidification

2.2.1 Environmental impact

There is particular concern about the impact of ocean acidification on coral reefs because the reduction in coral growth and weaker coral skeleton may increase erosion and make reefs more susceptible damage. Other organisms such as crabs and molluscs, which are important food sources, will likely be affected by ocean acidification.

2.2.2 Social and economic

Coral reefs serve as spawning and nursery ground for many fish species, including commercially important species. It is estimated that declines in coral populations and coral reef extent will have significant impact on estimated 500 million people who depending on coral reefs for food, coastal protection, building materials and income for tourism[7].

2.3 Cumulative impacts

2.3.1 Interaction with other drivers

Ocean warming, ocean acidification and sea level rise have synergistic effects on many ecosystems, and also overlay the many direct human stresses on the marine environment, such as overfishing and pollution. For example, ocean warming and pollution are likely to aggravate ocean acidification, in particular in coastal areas. These stresses may be additive or multiplicative, with severe impacts for ecosystem function.

This has, for example, already led to significant change on the world's coral reefs. Over fishing and, in the case of the Caribbean, loss of sea urchins to disease, has led to low recovery from coral bleaching events due to low herbivory, leading to algal domination.

It has been estimated that around two thirds of the ocean and three quarters of areas within national jurisdiction show increased cumulative impact from human activities. This is driven mostly by climate change. Only ten percent

[6] Resolution 2/10
[7] Wilkinson 2008

of ocean area has very low impact[8]. However, cumulative impacts are challenging to assess, and the combined effects of ocean acidification and other ocean stressors is an area of research still in its infancy.

3. Action undertaken to address the effects of climate change on the oceans and to foster climate resilient sustainable development of oceans and seas

3.1 Science, data collection and awareness raising

Science and data collection

The Transboundary Waters Assessment Programme produced assessment reports. These assessments provide the overview of the status of the water systems of the world. The programme also contributed to raising awareness and foster cooperation among different stakeholders.

Building on the work of the Transboundary Waters Assessment Programme, Regional Seas Indicators Working Group adopted a core set of 22 indicators[9]. The indicators set also include one related to ocean acidification. It is expected that Regional Seas programmes will use these indicators in the future to implement monitoring programmes at the regional level. These regionally coordinated monitoring will help enhance the understanding of the impact of climate change on the marine and coastal ecosystems.

Awareness raising

At the Second Session of the United Nations Environment Assemblym Member States requested "*the Executive Director of the United Nations Environment Programme, in particular through the Coral Reef Unit and in cooperation with other relevant international organizations and initiatives, within the programme of work and available resources, to contribute to raising awareness through public outreach campaigns as well as the Global Environment Outlook assessment processes of the importance of the sustainable management of coral reefs and related ecosystems, including cold -water coral ecosystems*"[10]. Responding to the request, UNEP is planning to launch a global campaign on coral reef, drawing attention to the impact of climate change on coral reef.

3.2 Overview of existing legal and policy frameworks

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted at the Rio Earth Summit in 1992 as one of the three Rio Conventions. The Convention subsequently entered into force on 21 March 1994. Through the instrument, Contracting Parties set an overarching goal to stabilize greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

The Paris Agreement under the UNFCCC builds upon the Convention and aims to strengthen the global response to the threat of climate change, among others by "*holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 above pre-industrial levels*"[11].

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[8] Halpern et al 2014

[9] UNEP/EARS/WG.2/5

[10] Paragraph 10 of resolution 2/12 Sustainable coral reefs management

[11] Article 2 1(a) of the Paris Agreement

Under the global framework, the Regional Seas programmes support their participating countries in mitigating and adapting to climate change impact on the marine and coastal environment. The UNEP Regional Seas Programme was established in 1974 to address the accelerating degradation of the oceans and seas through the cooperation of neighboring countries. Eighteen Regional Seas programmes currently exist across the world and more than 143 countries participate in one or more of the Regional Seas programmes[12].

Although the Regional Seas Programme initiated as a pollution-focused programme, many regions have started addressing issues related to climate change. The Regional Seas programmes collectively consider climate change as one of the four key issues to be addressed in the coming years along with pollution, extraction of living and non-living resources, and governance. As such, they adopted climate change as part of the Regional Seas Strategic Directions (2017-2020)[13]. It states that the Regional Seas Conventions and Action Plans will aim to "[C]*create increased resilience of people, marine and coastal ecosystems, and their health and productivity, in line with the SDG Goal 13 and decisions made at the UNFCCC COP21*".

Some of the Regional Seas programmes have already developed their own strategic documents to address the effect of climate change in their respective regions. For example, under the Convention for Protection of the Mediterranean Sea against Pollution (Barcelona Convention), Contracting Parties agreed on Regional Climate Change Adaptation Framework for the Mediterranean Marine and Coastal Areas.

The Contracting Parties of the Amended Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Western Indian Ocean (Nairobi Convention) called for a regional climate change strategy to foster regional cooperation in addressing the impacts of climate change in the Nairobi Convention area.

Under the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention) and its Protocol Concerning Specially Protected Areas and Wildlife (SPAW protocol), the Caribbean Environment Programme is implementing conservation activities in line with international policy regimes such as UNFCCC.

3.3 Action aimed at fostering climate resilient sustainable development of oceans and seas

UNEP works through a Global Coral Reef Partnership with Regional Seas programmes and other partners to secure coral reef benefits in a changing climate. The partnership promotes good governance across public and private sectors, informed by current science and sound data on coral reef status and trends; climate change vulnerability; ecosystem service values and human dependence. The partnership thus protects coral reef biodiversity; builds climate resilience of reefs as well as dependent industries and communities; and makes coral reefs a part of sustainable development through a blue economy.

Through collaboration with the National Oceanic and Atmospheric Administration (NOAA) and other partners, downscaled climate model projections for coral bleaching conditions have been prepared for the world's coral reefs, at a resolution of 4 km. This identifies reef areas that are relative climate refugia, and as such it provides a key dataset in prioritizing reef management. A comprehensive analysis of mesophotic deep reefs, their ecosystem services, vulnerability, and management priorities was published in 2016, and a guide to resilience assessment of coral reefs for decision support has been prepared, to be published early 2017.

The Global Coral Reef Monitoring Network (GCRMN) is being strengthened as a global data and ocean

[12] The Regional Seas programmes are considered to be multirateral environmental agreements.
[13] UNEP/WBRS.18/INF8

observation network, to better track the status and trends of coral reefs. This will enable using coral reefs as an indicator system of climate change as well as ocean acidification impacts and also achievement of global targets and the Sustainable Development Goals (SDGs).

Broad use of these tools and approaches is facilitated at the regional level through the Regional Seas as well as demonstration and pilot projects implemented with partners.

3.4 Ocean-based adaptation actions Ocean-based mitigation action

Blue Forests Projects

The USD 4.5 million Global Environment Facility funded project entitled "The Standardized Methodologies for Carbon Accounting and Ecosystem Services Valuation of Blue Forests Project (i.e., 'Blue Forests Project') implemented by the UNEP and executed through the GRID-Arendal seeks to build on the current knowledge of carbon storage and sequestration and ecosystem services provided by blue forests ecosystems, namely mangrove forests, saltwater marshes and seagrass meadows, as to propose improved methods and approaches to value these aforementioned services.

This project aims to pave the way to coordinated on-the-ground payment for ecosystem services, carbon market schemes, conservation agreements, or other mechanisms that deliver protections for coastal ecosystems that are based on those values. The project is attempting to demonstrate this through on the ground project sites in Indonesia, Madagascar, Mozambique, Ecuador, and United Arab Emirates, with replication and up-scaling activities in Thailand, Kenya and the Dominican Republic.

The international exploration of blue forests at the project sites is facilitated by advisory panels in carbon science, the valuation of ecosystem services and policy. The project also addresses key 'blue forests' knowledge gaps, and provides experience and tools for greater global application.

In doing so the project contributes to ocean-based adaptation and mitigation actions through the promotion of better ecosystem management at project sites across the globe including Ecuador, Dominican Republic, Indonesia, Kenya, Madagascar, Mozambique, Thailand, USA and the United Arab Emirates. Project activities at these sites explore how to achieve goals in climate change by harnessing the values associated with carbon and other ecosystem benefits for natural coastal ecosystems, such as mangrove forests, seagrass meadows and salt marshes. These values are now being incorporated into many National Determined Contributions to the UNFCCC[14]. Additionally, the project has helped explore the potential climate mitigation benefits from ocean carbon sequestration resulting from marine life[15].

Coastal Ecosystem-Based Adaptation

UNEP is encouraging Member States to consider the application of Ecosystem-Based Adaptation (EBA). EBA is the term used to describe the use of ecosystem services, underpinned by biodiversity, as part of an overall strategy to help people adapt to the adverse effects of climate change. In many cases, EBA involves community-based participatory principles to adapting to climate change.

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[14] Herr, D. and Landis, E. (2016). Coastal blue carbon ecosystems. Opportunities for Nationally Determined Contributions. Policy Brief. Gland, Switzerland: IUCN and Washington, DC, USA: TNC

[15] Lutz SJ, Martin AH. 2014. Fish Carbon: Exploring Marine Vertebrate Carbon Services. Published by GRID-Arendal, A Centre Collaborating with UNEP, Norway: Martin, A., Landis, E., Bryson, C., Lynaugh, S., Mongeau, A., and Lutz, S. (2016). Blue Carbon - Nationally Determined Contributions Inventory. Appendix to: Coastal blue carbon ecosystems. Opportunities for Nationally Determined Contributions. Published by GRID-Arendal, Norway

For example, UNEP supports the Government of Grenada in developing a coastal EBA plan and initiating demonstration of on-the-ground coastal EBA activities. The following actions were undertaken including: (i) Vulnerability analysis to identify the vulnerable coastal areas, (ii) Validation of vulnerability analysis by stakeholders and selection of EBA options, (iii) Establishment of Coral Reef Nurseries and their management, and (iv) Out-planting of Coral to areas identified for rehabilitation.

In Seychelles, a training manual was developed and training was organised for the staff of the Ministry of Environment Energy and Climate Change and Seychelles National Parks Authority as well as some Praslin island-based non-governmental organisations on beach monitoring in March 2016. In mid-2016, the integration of coastal EBA into national planning processes was initiated. A review of existing policies, legislations and frameworks relevant for reef conservation in Seychelles is being undertaken and existing governance structures at Praslin Island relevant to coastal EBA is being assessed.

In 2016, Regional Training Workshops for Caribbean and African Small Island Developing States on Integrating Coastal EBA into Policy and Plans were organized to strengthen national government capacity of SIDS in the Caribbean and African regions to more effectively respond to climate change and reduce the vulnerability of coastal livelihoods and sectors to climate impacts.

To support the implementation of EBA, several knowledge products were produced including Coastal EBA Decision Support Tool[16] and the Coastal EBA Introductory Guide "Options for Ecosystem-based Adaptation in Coastal Environments - A Guide for environmental managers and planners" [17]. The guide is targeted at environmental managers in government agencies. It features sections on the value of coastal ecosystems, planning for adaptation, the importance of policy measures, a range of possible coastal EBA options, and ensuring long-term success of EBA initiatives.

4. Further action necessary to address the effects of climate change on the oceans

Ambitious climate change mitigation, exceeding the 2 degree target and even the 1.5 degree 'aspiration' of the Paris Agreement will be needed to avoid the most severe and wide-ranging impacts on coral reefs and dependent communities. Further research and awareness raising are needed to better address climate change impact on the oceans.

Coral reefs

Coral reef management need to be planned and implemented based on the high-resolution information on future bleaching that is now available. Protecting and reducing direct stress on climate "refugia" is a top priority because they have more time to respond positively to efforts that seek to reduce bleaching vulnerability. Such efforts include reducing land-based pollution, halting overfishing and preventing damage from tourism. Designing efforts based on resilience assessments of coral reefs will further enhance the efficacy of management, and will also support adaptation efforts.

Monitoring and reporting on coral reef need to incorporate variables that track climate change and ocean acidification impacts to better support environmental management, climate change mitigation and adaptation

[16] http://web.unep.org/coastal-eba/DST

[17] https://www.unep-wcmc.org/system/dataset_file_fields/files/000/000/380/original/Options_for_Ecosystem_based_Adaptation_in_Coastal_Environments_low-res.pdf?1462462607

planning. This may require new and inventive ways of combining conventional reef monitoring with new technologies. GCRMN should be further strengthened at the global as well as regional level to this end.

Further efforts into research and development of innovative coral reef management and restoration strategies are also needed, including increasing the thermal tolerance of corals and reducing vulnerability to ocean acidification. Further research into the cumulative impacts of climate and other stresses on coral reefs is also needed.

Emerging issues

Addressing emerging issues will to be important. For example, recently an unprecedented quantity of pelagic *Sargassum* has been washed away on the beaches of the Caribbean islands and the tropical Atlantic. Warming and changing of ocean temperature due to global climate change may have contributed to this unusual bloom of seaweeds in the regions but the exact cause is unknown. To enhance scientific understanding of the issue, the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection has agreed to consider this issue within their work programme. But further research is needed to understand the impact of climate change on this issue.