Tools and Guidelines for Oceans and Climate Change Actions

Contents

NOTE: Document is not yet completely referenced!

Introduction

The purpose of 'Oceans and Climate Change – Tools and Guidelines for Action' [insert final title] is to inform and engage policy makers on the issues related to oceans and climate change and to cement the oceans' place at any international and national climate change negotiation table.

This document is divided into two main parts. First, it presents an overview of the interactions between oceans and climate change and the consequences involved. Second, it provides a set of recommendations for ocean and climate change policy and implementation actions.

This document will provide information about the impacts of climate change on the oceans and guide the development of marine-related climate change initiatives for use by those involved in climate change negotiations and future implementation activities.

Readers wishing to pursue the issues and proposed solutions in greater detail are referred to the cited literature [and /or to the organizations listed.]

1. People, the Oceans and the Climate

People, the oceans and the climate are inextricably linked. The circulation patterns of the oceans' currents make our planet inhabitable. About half of the oxygen in the atmosphere comes from the oceans. Large sectors of the global economy depend on ocean related commerce, including fisheries, tourism and shipping. Marine ecosystems provide us with several goods and services. Many people throughout the world rely on the oceans for their basic, caloric needs. In 2006, fish provided 2.9 billion people with at least 15% of their animal protein intake (FAO SOWFA). This number increases to nearly 100% for some small island nations. [Insert economic figure] Regardless of where we reside, we live on Planet Ocean and depend on healthy ocean ecosystems and the services that they provide. The oceans are the life support system for our planet.

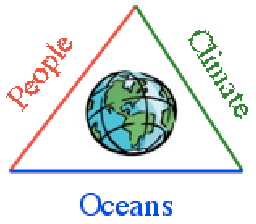
People, the oceans and the climate are inextricably linked

The oceans cover over 70% of Earth's surface and are so immensely deep that they contain over 90% of the inhabitable space for life on the planet. Every corner of this space is filled with remarkable biodiversity, ranging from relatively simple, but extraordinarily abundant microbes to some of the most social and intelligent animals on Earth, the whales.

The oceans cover over 70% of the Earth's surface

Unfortunately, the vast size, production, and diversity of life in the oceans have given us false comfort. For millennia, humans have worked tirelessly to take most of what is good out of the ocean and replace it with hydrocarbons, organic pollutants, nutrients, plastics, and sediment, never imagining that we could alter such a system. Now, the oceans are facing new and substantial threats as a result of climate change. The scale and rate of environmental change driven by increases in concentration of greenhouse gases in the atmosphere is unprecedented in human history (IPCC 2007). Alterations to the marine environment will negatively affect the ocean's ability to continue to support ecosystems, human populations, and cultures

In the following sections, the relationships between the People, the Climate and the Oceans will be discussed further, in order to ensure an overarching understanding of the issues involved.



[Insert similar graph on People – Climate – Oceans like shown on the left]

1.1 Oceans acting on Climate

Earth's climate is a result of the physical, chemical, and oceanographic properties of its components. Both regional and global climate patterns depend on long-term interactions between the oceans and the atmosphere.

The oceans play a complex role in our climate system [and in its ongoing change] (Rahmstorf & Richardson 2009). They store most of the sun's energy and act as a [the most] significant global heat buffer. Half of Earth's anthropogenic surface warming has been absorbed by the oceans, postponing the consequences of our actions and delaying more severe climate change impacts. The oceans also act like a giant central-heating unit, pumping massive amounts of warm water and air toward the poles and cold water and air back to the tropics. These patterns heat places like Europe and New Zealand and cool places like southern California and coastal Peru. The consistency of ocean currents keeps these regions from experiencing large climatic and seasonal swings that they might otherwise. Instabilities in the ocean currents caused by climate change could lead to major regional shifts and forced human migrations in the future.

The oceans play an integral part in influencing our climate and are intrinsically linked to the atmosphere:

- they store heat
- they transport heat around the global
- they provide water to the atmosphere
- they freeze and thaw at the poles
- they store and exchange gases, including CO_2, with the atmosphere

Furthermore, the oceans play a major role in wind and precipitation patterns. Cloud formation (evaporation), cloud movement (wind), and rain/snow (condensation) are all linked to the oceans. Weather systems, such as the Indian monsoon, are a direct result of the interaction between the oceans and continental masses. Water vapor, which evaporates over the oceans, moves over land and falls as precipitation because of ocean circulation patterns and the differential absorption of heat by the oceans and by land or air.

Sea ice also affects climate. Most of the sun's energy is reflected away from the Earth when it hits ice, cooling the Earth's surface. The opposite is true when sea ice melts. For example, when the Arctic becomes warmer, sea ice cover shrinks, creating a feedback loop that amplifies warming and increases ice melting in a combinatorial manner.

Finally, the massive volume of the oceans causes them to act like a giant reservoir or sponge, soaking up carbon dioxide (CO_2) and heat and exchanging it with the atmosphere. The oceans essentially act as a buffer for Earth's climate. The oceanic uptake of CO_2 assuages the effect of global warming by reducing its concentration in the atmosphere. However, this continual absorption of CO_2 and heat changes the oceans in ways that will have potentially dangerous consequences for humans and for marine biodiversity.

1.2 Climate Change acting on Oceans

The oceans are affected by climate change in two primary ways, both as a result of their natural ability to buffer the atmosphere: ocean warming and ocean acidification. The oceans' surface is in a state of equilibrium with the atmosphere with respect to CO_2 and heat. As concentrations of either increase in the atmosphere, they increase in the oceans as well. These increases change the physical and chemical properties of the oceans and affect several oceanic processes.

Ocean warming has several consequences. A well-known example is sea-level rise. As water warms, it expands, and the ocean surface rises. Currently, only the first few hundred meters of the oceans are warming and expanding. Over time, this heat will move downward to greater ocean depths, increasing expansion and triggering further changes in sea level. Additional sea-level rise is caused by the melting of inland glaciers and continental ice sheets such as those resting on Greenland and Antarctica. New observations raise a general concern that the latest projected changes for both Greenland and Antarctica could have been underestimated by as much as 50% and that more severe sea-level rise has to be anticipated. If the current trend continues, sea-level rise of one meter or more is likely to be observed by the year 2100.
[Add latest info from recent Copenhagen science meeting]

Extreme weather events are also affected by ocean warming. Heat is energy, so as hurricanes and typhoons form, warming sea temperatures boost their destructive energy. While the frequency of these storms does not seem to be affected by climate change, their intensity is expected to increase with further change. This intensification puts both people and marine and coastal ecosystems at risk.

Additionally, with ongoing warming of the atmosphere and the oceans, key water masses could undergo possibly drastic changes. Ocean currents are driven by the interactions between water masses. The two most distinguishing characteristics of oceanic water masses are temperature and salinity. As the atmosphere warms and polar ice caps melt, surface waters become warmer and fresher. Such a change could have dramatic impacts on the global climate system. Ecosystems would suffer dramatic consequences that would also be harmful to humans. Recent observations suggest "hints of change" in ocean circulation (IPY) and that currents such as the Atlantic Heat Conveyor have weakened. To date however there is no clear evidence to support an imminent change in the ocean circulation currents.

The oceans absorb approximately 50% of anthropogenic CO_2 emissions every year, maintaining its equilibrium with the atmosphere. While increased concentrations of CO_2 in the oceans slow the atmospheric greenhouse effect, they put marine and human life in danger. Dissolved CO_2 in seawater lowers the oceans' pH level and leads to acidification. Ocean acidification is the change in ocean chemistry driven by the uptake of carbon, nitrogen and sulfur compounds by the ocean.

While there is uncertainty about many aspects of climate change, the geochemical processes driving pH changes are highly predictable. The uptake of atmospheric carbon dioxide is occurring at a rate exceeding the natural buffering capacity of the ocean, and the pH of the ocean surface waters has decreased by about 0.1 units since the beginning of the industrial revolution (IUCN 2008). A doubling of the concentration of atmospheric carbon dioxide, which could occur in as little as 50 years, could cause levels of change not seen for 65 million years in the marine environment (McLeod et al 2008, WGBU

2006). These changes lead to dissolution of calcium carbonate, a vital component to the skeletal structure of organisms, such as corals and calcifying plankton and algae. Future atmospheric CO_2 concentrations as low as 450 ppm could be high enough to cause marine ecosystems to look nearly unrecognizable.

Threshold: 450 ppm

O. Hoegh-Guldberg, et al. Coral Reefs Under Rapid Climate Change and Ocean Acidification Science 318, 1737 (2007);

Hoegh-Guldberg, O., Ed. (2007). Vulnerability of Corals of the Great Barrier Reef to Climate Change, Great Barrier Reef Marine Park Authority and Australian Greenhouse Office, Australia.

Southern Ocean acidification: A tipping point at 450-ppm atmospheric CO2, Ben I. McNeila and Richard J. Matear

Finally, as the oceans continue to absorb heat and CO_2 from the atmosphere, their ability to buffer changes to the atmosphere decreases. This continued dissolution, as well as ocean warming and changing wind patterns reduces the ability of the ocean to take up additional CO_2 from the atmosphere. As the oceans' capacity to act as Earth's biggest carbon sink diminishes, the atmosphere and several terrestrial ecosystems, including the human ecosystem, will take the brunt of further change.

> Much as the oceans' vastness led to humanity's false conclusion that we could not affect them negatively, their incredible ability to buffer our atmospheric activities has given us a similar false hope that we can continue with business as usual, with respect to carbon emissions.

Outlook: Methane

The sea floor contains large quantities of carbon in the form of methane hydrates, on a similar magnitude as the total worldwide coal reserves. Methane hydrates are stable under high pressure and low temperature. Currently, there is little risk of a sudden and hazardous release of large quantities of methane from such oceanic sources during this century. However, if ocean warming penetrates into lower ocean layers and sediments, a gradual release of this potent greenhouse gas could be induced, with unknown consequences.

1.3 Vulnerable Biodiversity: Ocean Systems

The remarkable diversity of life in the oceans has evolved to fill habitats and niches created by the physical and chemical properties of the oceans. Anthropogenic release of GHG leads to changes in these properties, in response to oceanic absorption of heat and CO_2, respectively. Shifts in marine life and the services it provides are associated with these changes in oceanography. These shifts may sometimes cross irreversible thresholds and become permanent, changing the system forever. These changes are further amplified by the synergistic nature of greenhouse gas emissions and other human activities (e.g., agriculture, fishing, and costal development) that weaken ecosystem resiliency and lead to local or even global extinction of some pivotal species.

Global Changes

Nutrients and energy travel through ocean systems from microbes to whales (and people) through complex and precise food web dynamics. Changes to any part of the web can cause cascading effects that alter entire systems. Every link in marine food webs has the potential to be negatively affected by continued greenhouse gas emission and global climate change.

The base of the ocean food webs is comprised of a huge diversity of primary producers, ranging from microscopic plankton, to kelp, to seagrasses. Alterations to global oceanography could lead to changes in species composition in these communities (IPCC 2002). Both winners and losers are expected, but it is difficult to predict whom the winners will be, and some winners could be quite detrimental to their respective ecosystems (IPCC 2002). For example, when harmful, toxic algae succeed and become the most abundant species in the community, it is very difficult for individuals of other species to survive and recover to former levels. The boom and bust of individual species associated with disturbed ecosystems is buffered under normal, healthy conditions where other species offer checks and balances. Under increasingly altered systems, unpredictable swings in diversity and abundance of the planktonic community can be expected (IPCC 2002, xxxx).

Under increasingly altered systems, swings in diversity and abundance of the planktonic community – and hence the whole ocean food web – can be expected.

The warmer, fresher surface water associated with the oceans on our warming planet lead to stratification (Jackson 2008) – where water no longer moves vertically in the water column – that can trap valuable nutrients in the deep ocean, far from the well-lit upper ocean where phytoplankton can transfer them into energy and serve as a pool of food, available to higher levels in the food web. This phenomenon has implications for some of the most productive parts of Earth's oceans, where upwelling of deep waters and nutrients supports massively abundant surface ecosystems. If suppression of upwelling occurs to *any* degree, fisheries, and the people and wildlife that rely on them will certainly be negatively affected.

Warming temperatures will undoubtedly change the **geographical ranges of marine species**

In addition to changes in community composition and production in ocean ecosystems, warming temperatures will undoubtedly change the geographical ranges of marine species. Species are already migrating and occurring at higher latitudes than ever before. Geographic extensions of tropical species are being discovered regularly (reference). As the tropics warm, it is unclear if these species will be able to adapt or if they will only be able to migrate, but recent research implies that heat-adapted species are already near the physiological limit of their temperature range. There might not be populations or species available to replace them as they move. Furthermore, species endemic to closed basins, like the Gulf of California or the Mediterranean Sea do not have any place to go and might simply be lost (Cheung et al. 2009). Similar changes in depth range can be expected, as species shift down in the water column to escape warming surface waters. While these migrations seem like viable adaptations, it is unclear how successful species can be when moving over these distances and depth, and life history characteristics that rely on other environmental cues, such as day length and tidal cycle, may not adapt fast enough for continued success.

Beneficial, aesthetically pleasing, keystone species such as whales, sharks or turtles are not the only ones that will be able to extend their ranges with ocean warming. Dangerous invasive species, that cause disease and broad scale environmental destruction, can also migrate and are often more successful in weak, altered systems. As these species move into more pristine ecosystems, they can potentially cause serious harm before direct impacts of climate change are even observable.

In addition to the effects associated with warming, marine ecosystems are expected to show drastic changes associated with ocean acidification within the next 50 years or less. Several important planktonic primary producers rely on calcium carbonate to form protective shells. Under acidic conditions (as described above), calcium carbonate dissolves and these organisms are put at risk. Because these producers constitute the bottom of the food web, this risk can be expected to resonate throughout the web, all the way to important commercial fisheries and the people who rely on them. A similar problem is expected for corals, which also rely on calcium carbonate for skeletal production (see below).

Threatened Ecosystems

One example of a marine ecosystem at risk from climate change is the coral reef. Coral reefs are the most diverse ecosystem in the oceans and support several hundred thousand (if not millions) species. Corals are extremely vulnerable to climate change because of their narrow range of physiological constraints and close proximity to human population centers and the threats associated with those centers. Millions of people around the world rely on coral reef fisheries for their livelihoods and for protection from dangerous ocean storms.

Corals build their skeletons (and massive reefs) out of calcium carbonate. With the continual lowering of ocean pH associated with uptake of CO_2, corals are in danger of losing this ability (Jackson 2008). The subsequent flattening of reefs from three-dimensional matrices of habitat to homogeneous 'parking lots' of sea bottom could lead to the loss of unique, marine species from all branches of the tree of life.

Thermal stress causes **'coral bleaching'**, a phenomenon where corals expel the symbiotic micro-algae that provide them with energy and pigment. Corals become white as their skeletons become visible, and they become weak and prone to disease, algal overgrowth and mortality.

Corals are also quite susceptible to warming surface waters. They mostly live in shallow, surface waters that heat quickly, and they are adapted to live near the upper limit of their temperature range (IPCC 2002). Even slight, temporary warming events can lead to coral bleaching and widespread mortality. Increases in global sea surface temperature imply that coral reef thermal thresholds will be exceeded more frequently and this is projected to result in more frequent and more intense coral bleaching events and widespread mortality. According to the 2008 global world reef status report, the world has lost 19 percent of its coral reefs. This report, released by the Global Coral Reef Monitoring Network, also shows that if current trends in carbon dioxide emissions continue, many of the remaining reefs may be lost over the next 20 to 40 years (Wilkinson 2008).

Deep sea reefs are rare and unique ecosystems that grow slowly and experience very little environmental variability. Like their shallow water counterparts, deep sea corals rely on calcium carbonate for skeletal production. Within the next 90 years, up to 70% of deep sea corals are expected to be negatively affected by ocean acidification alone. Without mitigation of CO_2 emissions, this ecosystem will be severely impacted.

The International Polar Year announced new evidence that the **Antarctic and Arctic** regions are **warming faster than previously thought**.

Leading scientists now predict that within the **next 10 years the Arctic could be entirely ice-free during summer months**.

At the other end of the temperature spectrum, the polar ecosystems face different risks than tropical ecosystems. The most dominant feature of the polar landscape is ice. Huge mountains of snow and ice rise above the ocean's and land's surface near both poles. Above the water line, the ice serves as a necessary refuge for polar bears and ringed seals that use it for hunting, transportation, and reproduction. These impressive species are at risk of endangerment or extinction if the ice continues to melt at current rates. Below the water line, the interface between the ice and the seawater is a region of high primary production (the bottom of the food web) for the polar seas. Phytoplankton obtain nutrients from the ice and use them to grow and reproduce. Without nutrients from the slowly melting summer ice, production regimes will undoubtedly change. Recent data imply that sea ice melting at the poles is happening faster than previously expected, and researchers expect the Arctic to be totally ice-free during the summer in less than ten years.

Additionally, with continued ocean warming, polar ecosystems will be invaded by temperate species that are migrating to higher latitudes (Cheung et al. 2009). Furthermore, much like species in enclosed basins, polar species are essentially "enclosed" by their inability to travel to cooler regions. The forced interactions between polar species and temperate colonizers will again lead to winners and losers, but in this case, polar species may be totally lost under the physiological and ecological pressures.

A final group of ecosystems that will be affected by continuing climate change and greenhouse gas emissions are those along coasts. Coastal ecosystems straddle the interface between the oceans and the continents and are often the most heavily impacted by human activity. River deltas, coastal plains, coral atolls, barrier islands, lagoons, beaches, estuaries, salt marshes, and mangrove forests are some of the numerous systems along the oceans' borders. With expected changes in sea level and higher intensity of oceanic storms, the primary threats from climate change to coastal ecosystems are physical in nature. Saltwater intrusion, inundation, and erosion will continue to threat the structure of these systems. Because coastal species have adapted to live in a very narrow band of specific habitat, any alteration to this area could have serious negative consequences.

Without carefully planned mitigation and adaptation strategies, all of the unique ecosystems and species discussed here could be at risk of severe damage and irreversible loss.

1.4 Vulnerable Biodiversity: People

Social/Economic impacts

- -Environmental Refugees/Forced Migrations
- -Human Health
- -Fisheries and Aquaculture
- -Tourism
- -Coastal Development
- -Shipping

2. Action recommendations

2.1 Mitigation

To reduce climate change induced stresses in natural and human environments it is essential to drastically and immediately reduce global GHG emissions. The oceans offer some mitigation opportunities for anthropogenic climate change such as, for example, the increased utilization of renewable energy sources from the sea which can substitute fossil energy carriers. Other activities such as carbon capture and storage (CCS) or ocean fertilization could potentially offer some prospect for mitigation but have to be evaluated in terms of their effectiveness and risks to the marine environment.

- **CO_2 vs. other GHG**

The release of CO_2 as one of several GHG[1] has particularly far-reaching consequences for marine ecosystems: CO_2 not only contributes to the warming of the atmosphere and thus the oceans but also dissolves in seawater where it causes the oceans to turn acidic (WBGU 2006). This is not necessarily the case with other GHGs, which may have greater effects on global temperature while not affecting the oceans' pH value.

[Include 2 sentences of impacts and ramifications (socio-economical feedbacks) of ocean acidification, Harrould-Kolieb & Savitz (2008)]

<u>**List of specific action items:**</u>

- Define a CO_2 emissions ceiling for individual states or groups of states in addition to existing reduction commitments. This CO_2 cap would then need to be observed as a complement to the other commitments. The existing flexible mechanisms of the Kyoto Protocol (emissions trading, Clean Development Mechanism (CDM) and Joint Implementation (JI)) need to be revised in this regard (WGBU 2006);
- Include ocean expertise into the decision-making and revision process of emission targets and strategies;
- Fill the gaps in our understanding of the effects and implications of ocean acidification: document changes in ocean chemistry and biogeography across space and time, determine sensitivity of marine organisms, communities and ecosystems as well as assess uncertainties, risks and thresholds in the marine environment;
- Use the various research programmes currently underway to communicate results and continue to raise awareness (e.g. EPOCA[2], CARBOOCEAN, SOLAS-IMBER[3] Carbon Implementation Group (SIC), IOCCP2[4] and others);

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[1] Other greenhouse gases are: CH_4 – Methane, N_2O - Nitrous oxide, PFCs – Perfluorocarbons, HFCs – Hydrofluorocarbons, SF_6 - Sulphur hexafluoride

[2] EPOCA - European Project on Ocean Acidification

- ➢

- **Marine renewable energy sources**

The oceans' potential for renewable energy resources is vast: coherent with the proportion of the Earth's surface, the oceans receive more than 70 per cent of the Earth's received sunlight and almost 90 per cent of the wind energy (Czisch 2005). From this theoretically available energy only fractions are so far technically and cost-effectively available (WGBU 2006). Today's commercially applied marine renewable energy resources include wind, wave and tidal energy.

The competing uses of coastal areas however reduce significantly the potential of operating marine renewable energy sustainably. In order for renewable energy sources to be viable in the long-term other environmental aspects have to be taken into account. High-density installation of large numbers of systems would lead for example to considerable habitat changes, e.g. through noise emissions, seabed and shoreline disturbances, wildlife entanglement and other effects such as underwater cables.

No general formula exists to establish a threshold of significance within environmental impact assessment requirements. The variety of sites, ecosystems, and technologies make generalizations difficult.

[Please advice or provide documents on latest marine renewable potentials and outlook on technologies]

[Include outcomes, new finding, and recommendations from Global Marine Renewable Energy Conference 2009]

List of specific action items:

- ➢ Make informed decisions regarding the deployment of marine renewable projects and their likely impacts on the marine environment;
- ➢ Thoroughly test and evaluate marine energy extraction devices in terms of their performance, costs and environmental impact comparing short vs long-tem effects;
- ➢ Increase the incentives for the application of the most effective marine renewable energy resources;
- ➢ Develop and support resources that have the potential for desalinating salt water into fresh water, as well as producing sustainable, clean electricity;

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[3] IMBER - Integrated Marine Biogeochemistry and Ecosystem Research and SOLAS - Surface Ocean-Lower Atmosphere Study

[4] IOCCP2 - International Ocean Carbon Coordination Project

- Revise environmental impact assessments [check with IUCN – Energy] and make them an essential part of the development process and highlight the potential impacts on the marine environment;
- Design conflict resolution frameworks for marine renewable energy siting and development, ensuring that facilities are designed and located to minimize the immediate effects on marine ecosystems;
- [Check on forthcoming IUCN / E.ON guiding principles to ensure best private sector practice]
- Encourage further research on the development of new technologies for the extraction of renewable energy from the oceans;

- **MPAs as carbon sinks**

Some coastal ecosystems are important natural carbon sinks, especially tidal marshlands and mangrove swamps. Tidal floodwaters contribute inorganic sediments to intertidal soils, but more importantly, they saturate the soil and reduce the potential for aerobic decomposition. Anaerobic decomposition is much less efficient, enabling accumulation of organic matter in the soil, and the effective carbon sink. Seagrass bed carbon burial rates are about half as high as those for mangroves and salt marshes by area (Duarte et al, 2005).

It has been estimated that each molecule of carbon dioxide sequestered in soils of tidal salt marshes and mangrove swamps probably has greater value than that stored in any other natural ecosystem, due to the lack of production of other greenhouse gases (Chmura, 2009). In contrast to freshwater wetland soils (Bridgham et al. 2006), marine wetlands produce little methane gas, which is 25 times more potent as a greenhouse gas (based upon a 100-yr time horizon) than carbon dioxide (Forster et al. 2007).

With sound management coastal ecosystems can thus remain efficient CO_2 sinks rather than becoming CO_2 sources. Unfortunately all three of these ecosystems are being lost at rapid rates, including through deforestation, sedimentation, aquaculture development, reclamation, dredging, filling, drainage, coastal construction and now sea-level rise. Mangroves have been reduced to less than 50% of their original cover (Spalding et al.1997, Valiela et al. 2001). Integrated Coastal Management incorporating Marine Protected Areas that cover land and water is one method of protecting these ecosystems and to halt their destruction.

Studies indicate that healthy ecosystems, characterized by high species diversity show increased ecosystem function. These functions include measures such as ecosystem stability, faunal biomass and role in aspects of the carbon cycle. Environmental impacts from fishing disrupt the structural integrity of marine ecosystems, reducing their diversity and negatively impacting important aspects of ecosystem function and services. Whilst such changes may benefit a few species such as scavengers and rapidly growing ephemeral species, in general, structural degradation of ecosystems is a prerequisite to more serious regime shifts and ecosystem collapse (hysteresis).

[Fish excretion and their role in maintaining the ocean's delicate ph balance – comments? Wilson et al. (2009)]

[Fish and their positive impact on the ocean's carbon cycle – comments?, references?]

List of specific action items:

- Adopt and implement adaptation strategies to improve the oceans role as carbon sink, e.g. MPAs;
- Effectively create MPAs to be to be able to adapt to and shift over time due to climate change;
- Understand and quantity the magnitude of the biological pump – the amount of carbon material bound through photosynthesis and transported to the deep ocean layers and the role of various phytoplankton species as carbon sinks as well as the carbon pump – the amount of carbon material bound by specific groups of organisms producing calcium carbonate;
- Collect observation data covering large areas of the oceans over long periods, particularly on regard to their nutrient saturation, plankton (especially zooplankton) and calcifying organisms;
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- **Reducing pollution from shipping**

Ships, like all modes of transportation that uses fossil fuels, significantly contribute and exacerbate the greenhouse gas effect as well as ocean acidification by emitting carbon dioxide, black carbon (BC), nitrogen oxides (NOx) and nitrous oxide (N2O) (Harrould-Kolieb 2008). This endangers the survival of natural ecosystems as well as it does pose a threat to public health and welfare.

The shipping industry is responsible for 4.5% of all global emissions of CO_2 (reference). "In fact, if global shipping was a country it would be the sixth largest producer of greenhouse gas emissions" (Harrould-Kolieb 2008:2). As a part of a global effort to stabilize atmospheric CO_2 concentrations, the carbon dioxide generated by ocean shipping should be integrated more closely into emissions reduction strategies.

Black carbon, which is a solid and not a gas, is made up of fine sooty particulars emitted during the incomplete combustion of carbon fuel sources and may be second only to carbon dioxide in terms of direct contribution to a global rise in temperature (Harrould-Kolieb 2008). Black carbon is contributing in two ways to the warming: through direct absorption of heat in the top of the atmosphere, and by lowering the Earth's albedo effect – the amount of solar radiation reflected back to the atmosphere. The impact of the latter is most significant in regions which are heavily characterized by snow and ice such as the Arctic. By directly absorbing the sunlight, black carbon is accelerating the melting of the snow and ice on which it is deposited and is triggering positive feedback loops: The melting is leading to a higher concentration of black carbon particles which in return reduces the amount of reflected sunlight and accelerates the melting of snow and ice (Harrould-Kolieb 2008).

[Bunker fuels and IMO]

List of specific action items:

- Implement and create incentives for technical and operational measures and management improvements that contribute both to abating ocean pollution and preventing atmospheric CO_2 emissions. Such measures include speed reductions, weather routing, fuel switching, specialized hull coatings, increased efficiency of logistic and voyage planning (Harrould-Kolieb 2008);
- Support and implement longer-term measures to reduce GHG emissions, such as fuel and energy efficient design of new ships, engines created specifically for slow steaming or the use of sail or kite-assisted propulsion (Harrould-Kolieb 2008);
- Integrate CO_2 emissions generated by ocean shipping more closely into emissions reduction strategies: set emission standards and call for specific operational procedures, such as speed restrictions to reduce emissions reductions (Harrould-Kolieb 2008);
- Support the set of international emission standards from the shipping industry (Harrould-Kolieb 2008);
- Implement and create incentives for technical and operational measures and management improvements for reduced energy needs while stationed at port;
- Improve the supply and encourage the use of green energy resources to reduce direct emissions in port areas by connecting to shore-based power;
- Accelerate implementation of black carbon regulations;
- Expand existing regulations to increase the use of clean diesel and clean coal technologies and develop second-generation technologies;
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- **Carbon Capture & Storage**

Carbon Capture & Storage (CCS) is considered as one option in the portfolio of mitigation actions for the stabilization of CO_2 concentrations. However its use is contentious since the possible impacts on marine biodiversity may be severe and have yet to be evaluated. This is a determining factor in the selection of specific CCS measures.

CCS is a process which consists of the separation of CO_2 from industrial and energy-related sources, the transport to a permanent storage location and the long-term isolation from the atmosphere (WGBU 2006).

The ocean and the marine environment are seen by many as an unsafe place to store carbon. CO_2 could be injected into the water column, however, due to the fast outgassing and interchange with the atmosphere, this form of CO_2 storage is unviable. Injections into the deep sea could, in contrast, ensure a longer residence of the carbon in the sea (IPCC, 2005), but even in this case the equilibrium between atmospheric CO_2 concentration and that in the sea would be re-established (WGBU 2006). Another option would be to inject CO_2 into geological formations such as saline aquifers below the sea floor. The pressurized injection of CO_2 into oil formations could facilitate the extraction of oil (WGBU 2006).

CCS does not reduce dependence on fossil fuels and the potential for associated conflicts

However, the uncertainties regarding the environmental sustainability of sequestration are manifold: risk of accidents during transportation, the potential risk of slow escape of stored CO_2 and the potential impacts on marine ecosystems and its species run counter to long-term climate mitigation options (WGBU 2006, IUCN xxx. WWF xxxx). Additionally, carbon sequestration does not reduce dependence on fossil fuels and the potential for associated conflicts (WGBU 2006).

The benefits and negative consequences of sequestration technologies need to be evaluated against other mitigation strategies such as improving energy efficiency and increasing the use of renewable energy sources. CO_2 sequestration should not divert from more sustainable emissions reduction strategies. Compared with CO_2 sequestration, intensive utilization of renewable energy resources is therefore regarded as the preferred option (WGBU 2006).

The 1972 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and its 1996 Protocol are the primary regulatory instruments. The 1972 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, in conjunction with its London Protocol could possibly be complemented by more comprehensive rules governing sequestration activities by a corresponding arrangement under the UN Framework Convention on Climate Change.

List of specific action items:

- Develop effective regulation in order to ensure safe deployment of CCS projects (e.g. London Dumping Convention / London Protocol, UNFCCC);
- Adopt measures on a global, regional and national basis to ensure that potential risks of CCS schemes have been carefully considered in advance and if allowed to proceed are subject to permits based on prior environmental impact assessments, advance notification and consultation, and requirements for effective monitoring and reporting of results;
- Ensure that CCS risks posed to ocean ecosystems do not outweigh any potential climate mitigation benefit;
- Support more sustainable emissions reduction strategies such as renewable energy resources and increase energy efficiency (e.g. UNFCCC, national renewable energy strategies);
- Increase incentives for deployment of renewable energy sources and energy efficiency standards are needed;
- Include ocean expertise into the decision-making and revision process such as the IPCC Guidelines for National Greenhouse Gas Inventories and the setting of emission credits coming from flexible mechanisms under the UNFCCC, e.g. emission rights or CDM credits arising from sequestration should only be traded with substantial deductions;

- Address the issue of purity of any carbon dioxide streams in advance to ensure that they are not mixed with other materials that may also be harmful in a marine environment;
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- **Ocean fertilization**

Ocean fertilization is a controversial method proposed for mitigating rising atmospheric CO_2 levels and associated climate change by stimulating net phytoplankton growth through the release of nutrients, such as iron, into areas of the ocean surface. Dying plankton will then sink to be trapped in sediment on the seabed. However, there are many questions regarding how much carbon dioxide actually is sequestered this way rather than dissolved into the seawater.

Ocean fertilization requires a solid scientific basis to move forward. So far, information about sequestration potential and environmental impacts is limited. Potential impacts include increased emissions of biogenic gases to the atmosphere, decreased oxygen content of the underlying waters, and alteration in the living marine community - from microbes to megafauna.

Latest findings from the Southern Ocean have demonstrated that the transfer of CO_2 from the atmosphere to the ocean to compensate the deficit caused by the additional stimulated phytoplankton growth was minor compared to earlier ocean iron fertilization experiments (AWI 2009).

Because potentially high amounts of carbon might be sequestered, ocean fertilization is considered by some as suitable for the carbon trading market. The commercial interests however in funding the scientific research might possibly bias the reported outcomes and influence the voluntary carbon market. The sale of carbon offsets for such research is premature.

<u>List of specific action items:</u>

- Allow extreme caution on proceeding with large-scale ocean fertilization activities before further environmentally-responsible studies are undertaken and improved understanding exists (e.g. London Convention / London Protocol, UNFCCC, CBD, UNCLOS, …);
- Fill the knowledge gaps of potential environmental impacts of ocean fertilization;
-

- **Other geo-engineering projects**

 # Adding lime (calcium hydroxide) to seawater increases its alkalinity thereby increasing the ocean's capacity to absorb CO2 and reducing its tendency to the greenhouse gas back into the atmosphere. The process could also help counter acid acidification.
 # Wave-driven ocean upwelling system to cool the upper ocean and enhance natural biological processes to absorb CO2

[Need more information: Please provide sources and advice on feasibility, impacts, policy and action recommendations etc]

To take away:

- The marine environment plays a crucial role in the global carbon cycle and it is essential to incorporate the oceans into international and national climate change negotiations. The oceans' potentials and limits should be recognized and further explored.

- Ocean acidification, driven by increased dissolution of CO_2 in seawater, is a major threat to the marine environment. The impacts on the natural environment and its socio-economical ramifications should generate additional and immediate action by the international community.

- The protection of our oceans is essential for tackling climate change. Properly enforced and managed marine protected areas (MPAs), for example, can help to maintain the integrity of marine ecosystems in the face of direct impacts from fishing and other human activities and subsequently increased resilience to climate change impacts and retain the oceans potential for carbon sequestration.

- Marine renewable energy sources are playing a vital role in reducing the use of fossil fuel. The integration of environmental impact assessments is essential to reduce adverse effects of renewable energy projects on the marine environment. Further research into and development of new marine supplied energy alternatives should help reduce CO_2 emissions and lead the way for a sustainable use of marine energy alternatives.

- CO_2 emissions, and pollution from ships in more general terms, should be regulated and included into national and international emission reduction strategies. The reduction of black carbon can diminish the effect of global warming and the melting of snow and ice it resides on.

- CCS does not reduce the dependency on fossil fuels. The injection of CO_2 in geological formation under the sea floor can only be an 'emergency' solution for a transitional period. Extreme caution is advised in regard to CO_2 injections into the water-column or deep sea.

- Large-scale ocean fertilization activities should not proceed before additional environmentally-responsible studies are undertaken and improved understanding exists. Latest findings have dampened the hopes to mitigate climate change through ocean fertilization.

2.2 Adaptation

Climate change is already happening. Its impacts are seen and felt by humans and natural ecosystems worldwide and will continue to become more pronounced for decades to come. The challenge for both societies and ecosystems is to prepare for and adapt to current and future climate change in order to minimize impacts and increase resilience. Taking action to adapt to climate change has become an indispensable complement to reducing greenhouse gas emissions. The costs for adaptation are much less than the costs of inaction.

2.2.1 People adapting to Climate Change

Coastal cities and communities will need guidance and support to anticipate the impacts of climate change and cope with changing ecosystems. Appropriate adaptation strategies need to be developed and implemented if people are to sustain their livelihoods and quality of life into the future (Marshall et al. forthcoming).

Social and ecological systems are intrinsically coupled and constantly exposed to change (Marshall et al. forthcoming). This means that social adaptation strategies can only be successful if they take into account ecological adaptation strategies and vice versa. Neither social nor ecological resilience strategies can effectively operate without incorporating knowledge from and support of the other. Resource managers for example should manage for resilience by designing strategies that can maximise conservation outcomes while simultaneously supporting the sustainability of resource-dependent industries and communities (Marshall et al. forthcoming).

Resilience

Resilience to climate change is the ability of ecological and human systems to cope and adapt to changes in climate -sensitive natural resources.

List of specific action items:

- Understand social and ecosystems' vulnerability – the character, magnitude, and rate of climate variation to which coastal communities and marine-based industries are exposed;
- Use vulnerability assessments to receive information about the comparative magnitude of socio-economic and ecological impacts associated with climate change and the urgency with which adaptation plans should be implemented (see Marshall et al. forthcoming);
- Assess the three main drivers of vulnerability (exposure, sensitivity, adaptive capacity) to create a framework for developing resilience-building strategies that are most likely to be effective and that are targeted to stakeholders who need it most (see Marshall et al. forthcoming);
- Increase adaptive capacity by revising management strategies in an active way: through monitoring of social conditions, experimenting with different strategies, learning from strong feedback loops and incorporating new information into the design of new strategies (see

Marshall et al. forthcoming). Active adaptive management needs flexibility, learning, reorganizing, developing and experimenting to be effective (Armitage, Marschke et al. 2008).

- Use Ecosystem-based Adaptation (EbA) as a key climate adaptation approach and apply it as an integral element of overall climate change adaptation in poverty reduction strategies and development planning

Ecosystem-based Adaptation (EbA)

Ecosystem-based adaptation encompasses the range of local and landscape scale strategies for increasing ecosystem resilience, maintaining ecosystem services and reducing the vulnerability of people, their livelihoods and nature in the face of climate change. In other words EbA manages human activities in the ecosystem context to help people prepare for and respond to climate change. EbA should be seen as the overarching approach under which tools such as marine protected areas, integrated coastal management and others should be construed.

- Develop sustainable, less destructive and alternative livelihoods for coastal and marine dependent human communities;
- Enhance the availability of natural resources as a source of food and other products important to livelihoods;
- Protect and restore natural areas of cultural or religious significance, including areas critical for the cultural survival of indigenous groups;
- Support indigenous peoples and local communities to adapt and enhance traditional knowledge systems and management practices to changing climatic conditions along the lines of EbA;
-

2.2.2 Oceans adapting to Climate Change

[Include:

concept of ‘last refugia’ / ‘provide evolving habitats’ – certain areas of the oceans have demonstrated a higher resistance to the effects of CC. Those areas – refugia – should be identified and specially protected
goals of protecting historic assemblage of species needs to be broadened as CC forces species to move beyond the refuge’s current boundaries (FWS DRAFT Climate Change Strategic Plan and Action Plan)
bring and adapt tools such as marine spatial planning into the area of CC (MSP aligns the most appropriate use of ocean resources and protection areas over the wide expanse of the ocean).
predictions on where species might migrate, protect potential suitable habitats and corridor situated within expected path of species (FWS)
predictive adaptation

expand adaptation tools to directly address fishery, coastal hazard, and energy aims jointly with conservation]

- ➢ Support coastal and marine adaptation strategies by using marine regional assessments as well as spatial mapping management tools and develop maps of the distributions of marine ecosystems, habitats, species, and human uses to identify priority areas for conservation, restoration, and management (national adaptation plans, …);
- ➢ Use rapid resilience assessment methodology to assess the resilience of different areas in order to establish adaptive management actions for future coral bleaching events;

2.2.3 Tools and Action Recommendations for Climate Change Adaptation

- **Marine Protected Areas (MPAs)**

A key management tool to address many issues affecting marine and coastal ecosystems and resources is the implementation of marine protected areas (MPAs). MPAs are a direct means of implementing the ecosystem approach and can help building resilience and adaptive capacity of ecosystems and people who depend on them.

[Add short sentence(s) on role of MPA and protecting fish (and hence storing carbon?)]

List of specific action items:

- ➢ Create ecologically coherent and effective networks of MPAs able to adapt and shift over time in response to climate change taking into account resilience, refugia, replication and connectivity approaches:
    - Identify and fully protect various marine habitats that are at low risk of succumbing to climate change and other anthropogenic impacts because these habitats will serve as refugia to help seed the recovery of damaged areas (Björk et al. 2006);
    - Create more protected areas in strategic ocean locations that have demonstrated resilience to climate stressors and/or are naturally positioned to survive climate change;
    - Protect multiple samples (replicates) of the full range of marine ecosystems and from a wide geographical range to reduce the risk that they will be affected by the same disturbance;
    - Include patterns of connectivity and synergistic relationships between different marine habitats and corridors which are proven as beneficial to their adjacent ecosystems to allow for ecological linkages and shifts in species distribution (e.g. synergistic relationships between seagrasses, coral reefs &mangroves);
- ➢ Create buffer zones to provide a transition between protected areas and intensively used areas;
- ➢ Involve a full range of stakeholders and governance arrangements that will ensure the continued supply of ecosystem services;
- ➢ **[more social related recommendations]**

- Create and expand appropriate enforcement mechanisms ;
- Use digital MPA design tools (examples include: MarineMap, Marxan);
-
-

- **Restoration of marine ecosystems**

Although many times sound management and natural recovery are more cost [and XX] effective, currently degraded marine ecosystems could be restored to meet resilience criteria. However, the elimination or reduction of non-climate induced impacts are the most efficient ways to restore critical ecosystems such that they are positioned to survive climate change impacts.

List of specific action items:

- Consider after careful review of feasibility and prospect of success marine ecosystems restoration strategies including seeding, assisted colonization, transplantation of seedlings or mature plants from donor beds;
-

- **Integrated Coastal Management (ICM)**

Many coastal zones face problems of deterioration of their environmental, socio-economic and cultural resources and are now threatened even more in face of climate change. ICM is promoting sustainable management of coastal zones covering the full range of information collection, planning, decision making, management and monitoring of implementation. ICM is an approach that balances environmental, economic, social, cultural and recreational aims, all within the limits set by natural dynamics.

List of specific action items:

- Revise traditional approaches to coastal management and implement adaptive responses to sea-level rise and climate change impacts in the broader context and the wider aims of coastal protection plans for sustainable development;
- Incorporate ecosystem-based adaptation into general coastal management and adaptation strategies;
- Strengthen the implementation of ICM and the empowerment of coastal states and communities;
- Develop sustainable, less destructive and alternative livelihoods for coastal and marine dependent human communities;
- Enhance the availability of natural resources as a source of food and other products important to livelihoods;

- Protect and restore natural areas of cultural or religious significance, including areas critical for the cultural survival of indigenous groups;
- Support indigenous peoples and local communities to adapt and enhance traditional knowledge systems and management practices to changing climatic conditions along the lines of EbA;
- Create climate change committees which include marine experts and involve the committee in the design of planning procedures and guidelines for Integrated Coastal Management Plans;
- Maintain and restore “natural infrastructure” such as mangroves, coral reefs and watershed vegetation as a cost-effective means for reducing vulnerability to storm surge, rising sea levels and changing precipitation patterns;
- Reduce incentives for harmful and vulnerable coastal development;
- Eliminate flood insurance subsidize for low-lying coastal areas;
- Introduce coastal protection subsidy for coastal works implementing EbA measures;
- Introduce stabilization strategies against increased flooding and erosion risk like special fill materials and retention ponds that trap sediments and nutrients before they enter the marine environment and harm ecosystems such as sea grasses;
- Keep or provide landward or seaward space for migration of natural ecosystems, e.g. mangroves;
- Maintain connectivity of ecosystems in production landscapes involving a full range of stakeholders and governance arrangements that will ensure the continued supply of ecosystem services;
- Create buffer zones or greenbelt to provide a transition between protected areas and intensively used areas;
- Use and develop Decision Support Systems (DSS) tool able to support decision-makers in the definition of appropriate actions in regard to climate change (e.g. DSS implemented within the Euro-Mediterranean Centre for Climate Change (CMCC) Italy);
-

- **Risk management**

Managing risk refers to a dynamic process developed and implemented on the basis of a coordinated strategy with the aim of managing environmental, socio-cultural and institutional resources so as to ensure sustainable conservation of coastal areas and ensure that they can be used in a variety of ways in future. In face of climate change risk management plans need to combine hazard mitigation, biodiversity conservation and adaptive coastal development.

To some risk management and adaptation strategies in large need a new management philosophy that accepts the axiom of “living with natural hazards” rather than the usual, policy of minimizing or eliminating the hazard though hydraulic and structural control works.

List of specific action items:

- Prefer soft armoring above hard engineering projects (diking, building levees, and hardening the coastline) which often lead to accelerated erosion and habitat loss;
- Establish national / regional committee to deal with climate change and disaster risk reduction (DRR);
- Integrate climate change and DRR requirements into environmental impact assessment guidelines and the policies of regional development banks;
- Build partnerships between DRR and climate change adaptation actors and seek for advice on how to use or include natural ecosystems into risk management strategies ;
- Elaborate legislation for coastal areas that incorporates climate change issues and highlight protection potential of natural ecosystem;
- Introduce coastal protection subsidy for coastal works implementing EbA measures;
- Design risk management policies taking into account the benefits of natural events and maintain the positive role that natural disturbances can have (e.g. floods and wetland ecosystems);
-
-

- **Valuing natural capital**

Often the benefits that natural ecosystems deliver to humans are recognized only upon their loss. The motivation for the development of spatially explicit mapping and valuation tools is simple: relative to other forms of capital, assets embodied in ecosystems are often poorly understood, scarcely monitored, and undergoing rapid degradation.

[Include sentence(s) on negative aspect of always making all decisions on info on economic value, which is not always entirely appropriate]

List of specific action items:

- Explicitly and systematically integrate ecosystem services into decision-making by individuals, corporations and governments;
- Advance rapidly the science of “ecosystem services” (the delivery of benefits from natural ecosystems to humans). In promising a return on investments in nature, the scientific community needs to deliver knowledge and tools to quantify and forecast this return;
-

- **Monitoring**

To gauge the resilience of marine ecosystems to current and future threats, they should be constantly [regularly] monitored to determine the effects of global and anthropogenic stresses over long time scales. The information should be used to strengthen adaptive management and development strategies.

[Feed in: monitoring / review process provide opportunity to determine whether new information or changing conditions warrant revisions of purposes, visions, or management goals (FWS)]

List of specific action items:

- Build the capacity of local monitoring staff and incorporate climate change resilience monitoring into long-term monitoring plans
- Implement monitoring programmes that provide feedback on the result of coastal management;
-

Resources:

[Please advice or provide any document/info on monitoring resources, communication platforms and networks]

Socioeconomic monitoring, social resilience and livelihood resources

Socioeconomic Monitoring initiative of the Global Coral Reef Monitoring Network (GCRMN) – www.reefbase.org/socmon

Sustainable Livelihoods Enhancement and Diversification (SLED) approach - www.coralionline.org

Community-based Risk Screening Tool – Adaptation & Livelihoods (CRISTAL) - www.iisd.org

Coastal ecosystem management and resilience resources

SeagrassNET

The Nature Conservancy's Reef Resilience Toolkit - www.reefresilience.org

Communication and exchange platforms

ELAN – the Ecosystems and Livelihoods Adaptation Network - http://www.iucn.org/about/work/initiatives/climate_news/_/climate_change_and_ecosystem_management/

AfricaAdapt –

- **Future research focus**

A better understanding of the impacts of changes in climatic factors (temperature, wind and ocean current patterns, etc.) on marine ecosystems is critical to the identification of adaptive measures, proactive management and the creation of effective reserve networks. Knowledge regarding the various ecosystem components must be integrated into improved ecosystem models and coupled with recent climate/ocean models.

More precise estimates of sea-level rise are needed to develop adequate coastal adaptation and ecosystem management plans. Further modeling will profit from an increased knowledge on the dynamics of continental ice masses and the dynamics within the oceans as well as on their interactions of atmosphere.

Additionally global models need to be downscaled into higher resolution models in order to facilitate the development of regional and local adaptive management strategies and this information is critical for local decision-makers.

Descriptions and forecasts of the state of the ocean are necessary to predict climate change and large scale phenomena such as El Niño and La Niña events, as well as local phenomena, such as hurricanes and tsunamis on human health. It is critical to expand and sustain ocean observations from space and integrate this information into risk management and coastal protection strategies

Development of models are needed that can predict, at regional and local levels, the likely impacts of climate change on fish and wildlife

The gaps in understanding of the effects of ocean acidification and implications for the food web and marine ecosystems need to be addressed. Other changes are expected to take place in the biogeochemistry of the oceans. Other aspects, such as the effects on oxygen balance and nutrient supply in the sea, are poorly understood and urgently need further study in order to recognize critical developments in good time.

Recent data suggests that fish excretions seem to play a key role in maintaining the ocean’s delicate pH balance. More research is needed to be able to make more confident observations on the carbonate buffer potential of fish.

2.2.4 Eliminate non-climate induced impacts

[Include:

Human actions are often the basis of threats to ecosystem productivity, while degraded ecosystems can have far-reaching impacts on human societies (Hughes, Bellwood et al. 2005, Marshall et al. 2009).
marine ecosystems have a greater chance to bounce back if they are protected from local disturbances by reducing non-climate induced stresses resilience will be build and ecosystem recovery promoted]

- **Fisheries management**

[Include:

climate change impacts on the food web and its ramification for commercial exploitation and food security;
fishing can modify the response of marine systems to climate variability and change and that less heavily fished marine systems are likely to provide more stable catches under conditions of climate change (Perry et al. 2009)
within the fisheries sector: take the interaction between climate, fishing and habitat destruction into account and to address them collectively;
fish have a huge positive impact on the ocean's carbon cycle (?)]

<u>List of specific action items:</u>

- Revised & strengthen existing management plans for fisheries and aquaculture and include potential climate change impacts, mitigation and adaptation responses;
- Include new management approaches such as ecosystem-based management which focus on the conservation of functional groups that support essential process and ecosystem services rather than only on targeted commercial species (Perry et al. 2009, Hughes et al. 2003);
- Include the ecosystem-based approach to fisheries and aquaculture throughout the entire resource-extraction, processing, supply and value chain (FAO 2008);
- Follow conservation objectives such as maintain ecosystems diversity, species diversity, genetic diversity within species, directly impacted species, ecologically-dependent species and tropic level balance (Perry et al 2009, Gislason et al. 2000);
- Eliminate impacts on fish populations through overfishing, discards and IUU (illegal, unregulated & unreported) fishing;
- Eliminate destructive fishing practices such as dynamite or cyanide techniques and implement restrictions of gear use (Grimsditch & Salm 2006);
- Implement legislation controlling destructive fishing techniques (Grimsditch & Salm 2006);
- Impose fishing licenses (Grimsditch & Salm 2006);
- Manage the exploitation of new emerging fishing grounds and mineral resources in the Arctic in a sustainable manner and with long-term precautionary approach;
- Agree to maintain an interim prohibition on bottom-trawling to reduce impacts on fish populations, marine ecosystems and to conserve the oceans potential as carbon sink;

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-

- **Aquaculture management**

[Please advice or provide any document summarizing action items on aquaculture]

<u>List of specific action items:</u>

- Reduce the destruction and the conversion of natural ecosystems such as mangroves into structures for aquaculture
- Develop ways to integrate aquaculture projects into Coastal Zone Management Plans (IUCN 2004);
- Critically select site by carrying out EIA to determine possible effects on the surrounding ecosystems and evaluate carrying capacity of the site (IUCN 2004, 2007);
- Consider secondary impacts on water quality into the development of management actions – e.g. temperature and disease organisms; temperature and nutrients on aquatic communities (Sierra Club);
- Use raw materials for food production that are certified as sustainable so as not to disrupt the populations of other fish species (IUCN 2007);
- Manage farms in a way that controls its effluents - Polycultures should be encouraged as it can recapture and use organic effluents (IUCN 2007);
- Culture whenever possible native species to help to lower the risk of the introduction of new/alien species (IUCN 2007);
- Maintain sustainable aquaculture by pairing for example low scale aquaculture within an MPA to help sustain the livelihood of the local population;

- **Land-based pollution**

[Information from UNEP/GPA will be added here. Please advice or provide any other documents summarizing action items re land-based pollution]

[Include:

human development and practices on land are threatening the health and resilience of coastal and marine ecosystems;

healthy marine ecosystems can better adapt to climate change and carry on providing humans with goods and services;]

List of specific action items:

- Improve land-use practices (e.g. agriculture) to decrease nutrient and sediment run-off from poor land-use practices into the sea;
- Reduce pollution from human sewage into the sea;
- Reduce pollution from flows of debris and toxic material into the sea;
- Eliminate the use of organic pollutant;
- Reduce land-based sources of pollution that contribute to lowering pH in coastal and ocean waters (IUCN Honolulu declaration);
- Increase filtration of effluent to improve water quality;
-

- **Ocean pollution**

[Please advice or provide any documents summarizing action items re ocean pollution]

List of specific action items:

- Reduce pollution from flows of debris from fishing and cruise ships
- Reduce inputs of nitrogen and sulphur oxides and ammonium compounds that contribute to lowering pH in coastal and ocean waters.
-

- **Marine resources extraction**

[Please advice or provide any documents summarizing action items re marine resources extraction: oil and gas, deep sea-bed etc]
[Include:
the possible gradual release of methane if warming temperature encroaches into deeper layers in the future;
the current disturbances resulting from mineral oil and natural gas production are the biggest threat to methane releases]

List of specific action items:

- Amend and adjust, as necessary, existing regulatory systems governing ocean mining (e.g. ISA, …);
- Comprehensively map occurrence of methane in the ocean to better understand the dynamics of methane in the oceans and to improve models. More research is necessary regarding the implications on mining of methane hydrates (risks and sustainability of energy source).
-

To take away:

- The protection of our oceans is essential for tackling climate change. Properly enforced and managed marine protected areas (MPAs), for example, can help to maintain the integrity of marine ecosystems in the face of direct impacts from fishing and other human activities and subsequently increased resilience to climate change impacts, retain the oceans potential for carbon sequestration and provide humans with xxxx.
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-
-
-
-
-

2.3 Social and financial issues

[This section is still very incomplete and needs further input.

Please read the following as a couple of suggestions which need further development.

Please advice and refer to any relevant document / project.]

- **Capacity building**

[Short intro sentence or paragraph will follow]

List of specific action items:

- Encourage cross-sectoral exchanges of information and experiences at national, regional and global
- Create, apply and disseminate communication and information processes that reach all stakeholders within different sectors
- Create new (regional) executive institutions that join banking, industrial, ecological and educational expertise into a single collective enterprise that can help build capacity within the region and advice nations and evaluate overall progress (from Pacific Ocean Scientific Consensus Statement)

- **Financial resources**

[Please read the following as a couple of suggestions which need further development.]

- Adaptation Fund

IUCN: Adaptation Funds under the post 2012 framework need to consider in their allocation and disbursement ecosystem-based adaptation, the value of biodiversity, and the linkages with economic and social development, gender equality and poverty reduction

- Strategic Climate Fund

- ACRED (Avoid coral reef ecosystem degradation): funding for local action to reduce climate impacts arising from CO2 (by Hoegh-Guldberg)

- establish market-based mechanisms to conserve ecosystem services

- use other funds such as global food security for example, not only biodiversity funds!

- Use funding from Cap & Trade mechanisms / carbon income for EbA / coastal protection, implementation of MPAs etc

- CC and financial crisis: stimulus packages need to be checked for climate change incentives – how is infrastructure planned etc …

- integrate value of resources into cost-benefit analysis

- FCCC/AWGLCA/2009/4 (Part II)

Parties have proposed the following options for generating new and additional financial resources:

(a) An assessed contribution from developed country Parties as a percentage of gross national product or gross domestic product;

(b) An assessed contribution from all Parties, except LDCs, based on a predefined set of criteria, including GHG emissions, respective capacity and population;

(c) Auctioning of assigned amounts or emission allowances at the international and/or domestic level;

(d) A uniform global levy on CO_2 emissions, with exemption for LDCs;

(e) Levies on emissions from international aviation and maritime transport;

(f) A tax on air travel;

(g) A share of proceeds from market-based mechanisms under the Kyoto Protocol.

(h) A global levy on international monetary transactions.

Possible action items:

- Link development funding to climate change and make it a conditionality for financing;
- Promote adoption of effective solutions such as incorporation of ecological principles in economic decision;
- Use of financial and market instruments such as environmental bonds, legacy trust, catch share programs and tax systems to create incentives for activities that promote ecosystem health;
-

- **Addressing the climate divide**

mainstream ecosystem-based adaptation into poverty reduction strategies and development planning as an integral element of overall climate change adaptation

Possible action items:

-
-

- Technology transfer: Strategies include funding mechanisms, capacity-building, international collaborative research networks, public-private partnerships, and using multilateral and bilateral trade cooperation agreements to create incentives.

- **Climate refugees**

[Include:
sea-level rise will lead to the inundation of coasts and small island states and will create ‘climate refugees’]

<u>List of specific action items:</u>

- Adopt innovative instruments of international law for refugees from sea-level rise;
-

- **Oceans and Health**

[Include:
the oceans are a key source of plants, animals, and microbes that are beginning to yield new and potent drugs for the treatment of human disease and that only healthy ocean can deliver those services;
the oceans are also a source of health hazards, harboring toxins and disease-causing agents that can present serious threats to human health]

<u>List of specific action items:</u>

- Develop more effective threat detection and monitoring systems;
- Enhance research on the causes and epidemiology of ocean-related health threats;
- Reduce stressors and cause for ocean health hazards;
- Protect key source of plants, animals, and microbes that are beginning to yield new and potent drugs;
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To take away:

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-
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3. Conclusions