

The Ocean and Climate Change

Tools and Guidelines for Action

Climate change is severely and rapidly impacting species, ecosystems and people around the globe. As both international and national mitigation and adaptation strategies are being discussed, the impacts of climate change and ocean acidification, as well as the ocean's role in mitigation and adaptation strategies, have largely been overlooked.

Over 70% of the planet is covered by the ocean. The ocean is the major regulating force in the earth's climate system and represents the largest carbon sink on the planet. Healthy marine and coastal ecosystems, and their services, are essential to maintain the earth's life support system. Climate change and ocean acidification are jeopardizing food security, shoreline protection, the provision of income, livelihood sources and sustainable economic development.

Rapid and significant action is needed now. This brochure highlights the most pressing climate change issues with respect to the ocean and presents a set of tools and guidelines for the implementation of marine climate change mitigation and adaptation strategies.

- Action Recommendations for Mitigation Strategies
- Action Recommendations for Ecosystem-based Adaptation
- The Impacts of Climate Change and Ocean Acidification
- A Changing Ocean – A Changing Land
- The Need for Immediate Action



ACTION RECOMMENDATIONS FOR MITIGATION STRATEGIES

Climate change and ocean acidification continue to have serious, adverse impacts on the marine environment with significant implications for people.

Several mitigation approaches are being developed and implemented in order to achieve a significant and rapid decrease in Greenhouse Gas (GHG) emissions. Such mitigation portfolios should include responsible, well-researched marine and coastal strategies.



QUICK FACTS

The ocean absorbs nearly one third of all the carbon dioxide (CO₂) we emit each year.

Increased levels of CO₂ in the ocean cause ocean acidification.

The ocean's capacity to store carbon emissions is decreasing, thus more significant CO₂ mitigation actions are needed in order to lower the impacts of climate change.

Vital coastal carbon sinks are being damaged and lost at a dangerous rate.

Healthy ecosystems support climate change mitigation strategies.



SIGNIFICANTLY AND RAPIDLY CUT CO₂ EMISSIONS

- Set stabilization targets for atmospheric CO₂ which adequately reflect the impacts of ocean acidification.
- Include the environmental and social costs of ocean acidification in climate change mitigation actions.
- Utilize ocean expertise in climate change mitigation decision making and revision processes.

RETAIN, MAINTAIN AND RESTORE NATURAL CARBON SINKS

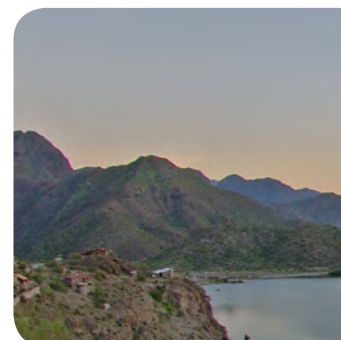
- Effectively apply marine and coastal management, conservation and restoration strategies, including marine protected areas and integrated coastal management, to increase the world's natural carbon sinks.
- Build and improve upon simulation models, in collaboration with field studies, to develop tools for improving and enhancing management plans, including optimal scenarios for carbon allocation, CO₂ uptake and carbon management schemes.

PROMOTE RESEARCH AND MONITORING OF THE OCEAN'S ROLE IN THE GLOBAL CARBON CYCLE

- Recognize the role of marine and coastal ecosystems as vital global carbon sinks.
- Develop adequate carbon management and possibly offset schemes for marine and coastal ecosystems.
- Enhance long-term monitoring of carbon in the ocean and support efforts to quantify the ocean's role in the global carbon cycle.

SIGNIFICANTLY REDUCE OTHER HUMAN STRESSORS

- Maintain healthy marine and coastal ecosystems and restore those that have been degraded.
- Apply an integrated, ecosystem-based coastal and ocean management approach.
- Revise and strengthen existing marine resource management plans.
- Drastically reduce land-based and marine pollution.

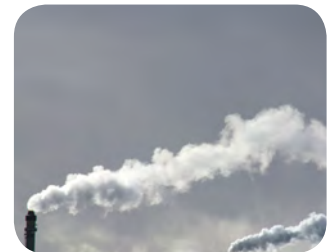


APPROACH LARGE-SCALE OCEAN FERTILIZATION ACTIVITIES WITH EXTREME CAUTION

- Prohibit large-scale ocean fertilization activities until there is sufficient scientific basis on which to justify such activities.
- Refrain from selling or offering carbon credits or offsets for ocean fertilization or other geo-engineering projects unless their safety, long-term effectiveness and net environmental benefits have been established.
- Develop and implement a transparent and effective regulatory mechanism for geo-engineering related research to ensure that these activities are subject to appropriate control and consultation.

APPROACH CARBON CAPTURE AND STORAGE (CCS) WITH EXTREME CAUTION

- Refrain from directly altering ocean chemistry by injecting CO₂ into the water column or the deep-sea.
- Refrain from setting investment incentives that could divert attention from the development and deployment of other more environmentally friendly mitigation strategies.
- Adopt effective measures and regulations, on global, regional and national scales, to ensure that potential risks of CCS schemes have been carefully considered.
- Introduce permits for CCS projects based on prior environmental impact assessments, advanced notification and consultation, and use of independent scientific reviews.
- Require continuous monitoring, reporting and inspection of CCS sites.

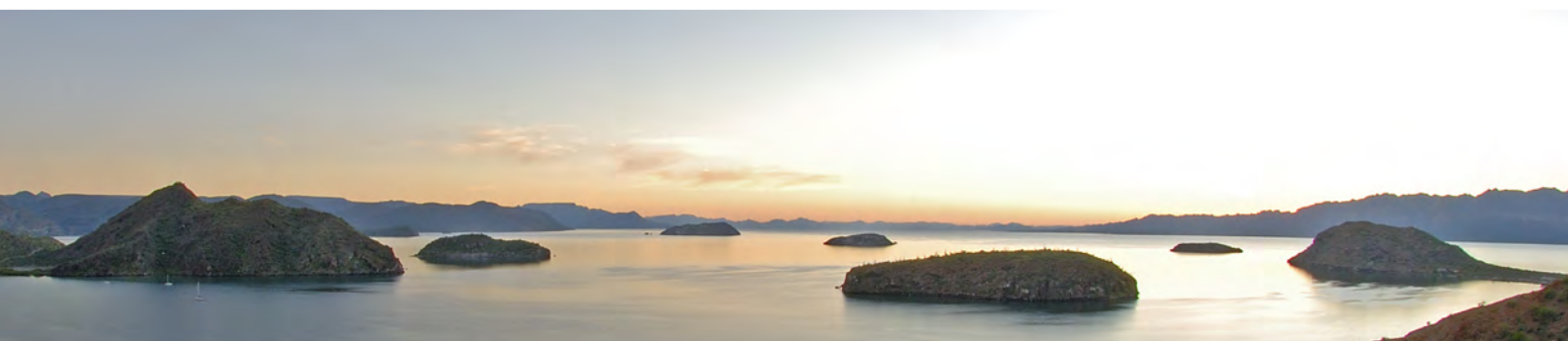


INCLUDE THE SHIPPING INDUSTRY IN CO₂ EMISSIONS REDUCTION STRATEGIES

- Regulate CO₂ emissions generated by oceanic shipping.
- Implement technical and operational measures for reduced emissions and management improvements.
- Support and implement longer-term measures of fuel and energy efficient design (e.g. slow-steaming engines or the use of sail- or kite-assisted propulsion).
- Create market-based incentives, as well as mandatory regulations, for management plans, efficiency strategies and design indices.
- Increase the availability and use of green energy resources for use as shore-based power.

PROMOTE AND INVEST IN ENVIRONMENTALLY SOUND RENEWABLE ENERGY PROJECTS

- Significantly reduce energy consumption.
- Make informed decisions regarding the deployment and impacts of marine renewable energy projects.
- Use best available information regarding environmental impact assessments.
- Facilitate the development of marine renewable energy resources through regional cooperation (e.g. grid-sharing between nations).
- Support renewable energy markets (e.g. guaranteed prices, feed-in tariffs or renewable energy payments).



ACTION RECOMMENDATIONS FOR ECOSYSTEM-BASED ADAP

Mitigation is absolutely essential to avoid long-term climate change and ocean acidification, the impacts of which are already seen and felt by humans and natural ecosystems in many regions of the world. Due to geophysical time-lags, the consequences of ocean warming and ocean acidification will continue to become more pronounced for decades to come. Ecosystem-based Adaptation (EbA), as part of larger climate change adaptation portfolios, can support and help people adapt to climate change.



WHAT IS EbA?

Ecosystem-based Adaptation (EbA) is the sustainable management, conservation and restoration of ecosystems in order to assure the continued provision of vital services that help people adapt to the adverse effects of climate change.

EbA increases ecosystem resilience to reduce human vulnerability in the face of climate change and can be applied to coastal and marine ecosystems to ensure that they are able to continue to provide vital services (e.g. storm protection) on which people rely.

EbA strategies can be more cost-effective than physical infrastructures and engineering projects and are often more accessible to the rural poor.

EbA should be considered part of a broader set of climate change adaptation solutions.



USE EbA TO HELP PEOPLE ADAPT TO CLIMATE CHANGE

- Maintain and restore key marine and coastal ecosystems in order to reduce social and economic vulnerabilities.
- Identify priority areas for protection, restoration, and management by using regional marine assessments, spatial mapping tools and other visualization tools.
- Increase ecosystem resilience and ensure continued provision of ecosystem services by reducing other human stressors on the marine environment, including: pollution, destructive fishing practices, habitat destruction and unsustainable coastal development.
- Protect natural buffers and plan for inward migration of coastal ecosystems such as mangroves and wetlands.
- Integrate the full suite of EbA actions into poverty reduction and sustainable development plans, whenever possible.

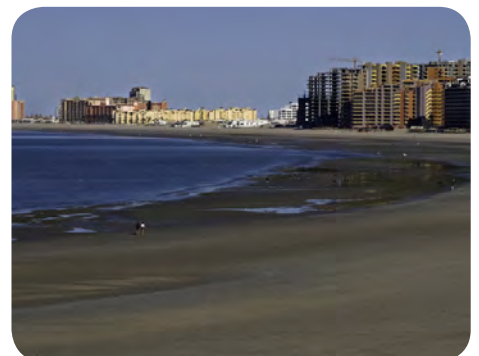


CONDUCT VULNERABILITY ASSESSMENTS

- Obtain information regarding the relative magnitude of social and environmental costs of climate change, and determine the urgency with which EbA strategies should be implemented.
- Develop EbA plans with properly targeted scenarios and strategies, and prepare for adaptive management responses.

INCLUDE EbA STRATEGIES IN RISK MANAGEMENT PLANS

- Maintain and restore essential natural infrastructures, such as mangrove forests, coral reefs and sand dunes, to reduce human vulnerability (e.g. to storm events).
- Introduce benefits for risk management projects that utilize ecosystem-based coastal protection measures to reflect the true value of ecosystem-services.
- Eliminate subsidized insurance and other benefits for development projects that alter natural systems to an extent that increases risk.
- Integrate EbA strategies into the policies of regional and international development banks to ensure adequate implementation and funding of EbA.





DEVELOP ADEQUATE FINANCIAL SUPPORT FOR EbA

- Eliminate subsidies and other incentives for unsustainable coastal and marine development projects and replace them with economic rewards for projects that undertake EbA and a wider ecosystem-based approach to development.
- Manage climate related socio-economic issues with traditional development goals to ensure that both can be achieved without competing for limited human and financial resources.

CREATE COMPREHENSIVE NETWORKS OF MARINE PROTECTED AREAS (MPAs)

- Significantly increase the size and number of fully protected areas to allow ecosystems to recover their full suite of services.
- Increase effectiveness of existing MPAs and ensure proper implementation of new MPAs.
- Encourage connectivity synergies between coastal and marine ecosystems by protecting ecological corridors.
- Establish “Predictive Protected Areas,” which provide some level of protection for areas expected to provide future refugia and areas that have demonstrated some resilience to the effects of climate change.
- Develop and implement new, creative enforcement mechanisms (e.g. locally empowered enforcement processes).

RESTORE FRAGMENTED OR DEGRADED ECOSYSTEMS, AND REESTABLISH CRITICAL PROCESSES

- Undertake marine ecosystem restoration projects (e.g. seeding, transplanting, or assisting colonization of coastal and marine plants, eliminating invasive species, demolishing unnecessary or unused structures, etc.) where appropriate.
- Develop and strengthen community-based restoration programs.
- Include sustainable use of ecosystem services as part of the design, implementation and management of restoration projects and sites.

STRENGTHEN AND DEVELOP LONG-TERM MONITORING AND RESEARCH PROGRAMS

- Ensure long-term monitoring to allow for adaptive management actions.
- Incorporate socioeconomics into environmental monitoring projects.
- Determine top research priorities and support the most appropriate existing institutions in their implementation.
- Support local and regional scientific institutions so that low-resolution, global findings can be applied to local and regional stakeholders.



THE IMPACTS OF CLIMATE CHANGE AND OCEAN ACIDIFICATION

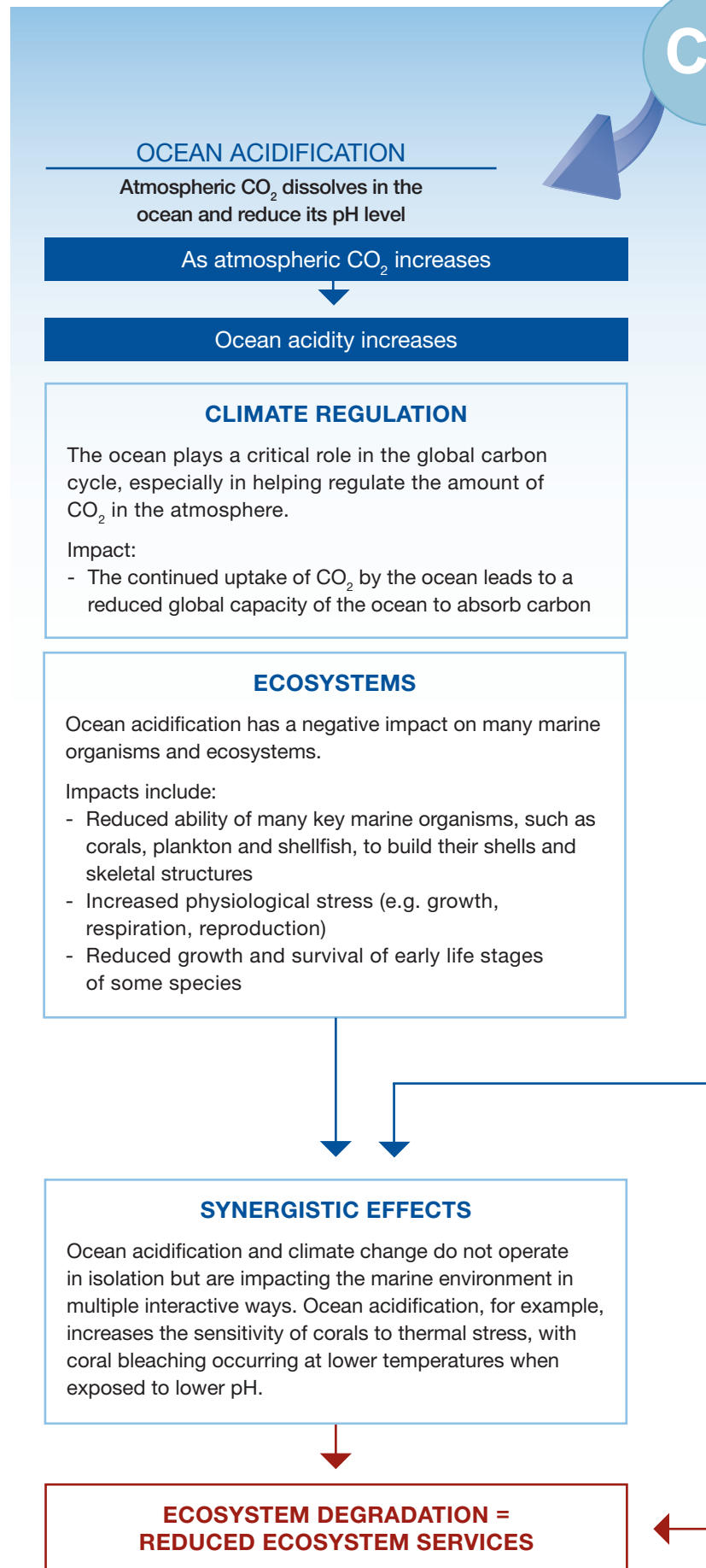
The ocean and its ecosystems sustain life on Earth by cycling oxygen and CO₂, regulating climate and temperature, and providing millions of people with food and income. However, these benefits and services are in jeopardy.

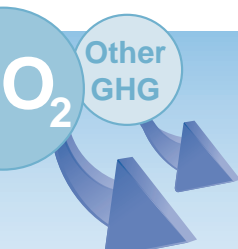
Sea-level rise, increased intensity of storms, changes in ocean productivity and resource availability, disruption of seasonal weather patterns, loss of sea ice, altered freshwater supply and quality are impacting local livelihoods, global economies, food security and human health. Due to significant geophysical time lags, anthropogenic effects on these natural processes will continue to affect the state of the world's ocean for millennia to come.



WHY DOES OCEAN ACIDIFICATION MATTER?

- A reduced capacity of the ocean to store carbon leaves more CO₂ in the atmosphere. This requires more significant CO₂ emission reductions in order to lower the impacts of climate change.
- As calcification rates of corals decrease, it is likely that reefs will erode at a faster rate than they are created. This loss has negative effects on the reproduction and life cycle of organisms that depend on reefs, as well as severe implications for the people who rely on them for shore protection, food and income.
- Ocean acidification has direct effects on commercially viable species by reducing the calcification rates of shellfish such as mussels and oysters. Impacts on planktonic primary producers can be expected to resonate throughout entire food webs and marine ecosystems and jeopardize commercial species by reducing their food supply.





OCEAN WARMING

The ocean interacts with the atmosphere by exchanging and storing heat.

As atmospheric temperature increases

Ocean surface temperature increases

CLIMATE REGULATION

The ocean plays an integral part in influencing the global climate.

Impacts include:

- Increased intensity of extreme weather events
- Changes in ocean currents

ECOSYSTEMS

Ocean warming has a negative impact on many marine organisms and ecosystems.

Impacts include:

- Increased ocean stratification; decreased ocean mixing
- Changes in the geographical ranges of marine species
- Changes in diversity and abundance of certain marine organisms
- Exceeding thermal thresholds (e.g. coral bleaching)

SEA-LEVEL RISE

As seawater warms, it expands, and the ocean surface rises.

The melting of inland glaciers and ice, due to high atmospheric temperatures, accelerates sea-level rise.

Impacts include:

- Beach erosion
- Saltwater intrusion
- Habitat destruction

OTHER HUMAN STRESSORS

Climate change and ocean acidification also interact with other human stressors exacerbating ecosystem degradation. Coastal and marine ecosystems are subject to stress from local and regional factors, such as overfishing, pollution, declining water quality and habitat destruction, and are more likely to exhibit diminished resilience in the face of climate change and ocean acidification.

WHY DOES OCEAN WARMING MATTER?

- An increase in extreme weather events endanger coastal populations and damage coastal infrastructure.
- Instabilities in ocean currents could lead to shifts in regional climate and weather patterns and trigger human migration.
- Ocean stratification impedes the mixing of ocean layers and prevents valuable nutrients from reaching surface waters.
- Permanent migration of species to higher latitudes and deeper depths could cause changes in local availability, endangering food supply and altering traditional fishing grounds and rights.
- Impacts on primary producers such as phytoplankton cause changes in species composition and biomass in pelagic communities. These changes could affect all levels of the marine food web.
- Some marine organisms could approach physiological thresholds in temperature (e.g. coral bleaching).
- Rising sea levels increase beach erosion and saltwater intrusion jeopardizing shore protection and coastal infrastructure, impacting human health, and risking human displacement.



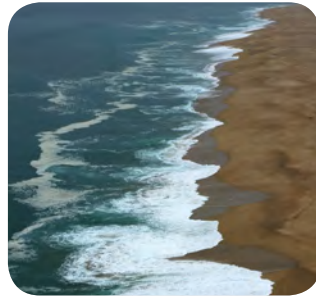
Healthy and well functioning ecosystems are extremely valuable for climate change mitigation and adaptation strategies. Healthy marine ecosystems sequester more carbon than degraded systems and help people adapt to a changing climate. These ecosystems provide services and exhibit higher resilience to other problems. Therefore, it is essential to actively reduce destructive coastal and marine practices and implement conservation initiatives that focus on maintaining a functioning environment for future generations.

A CHANGING OCEAN – A CHANGING LAND

People, the ocean and the climate are inextricably linked: the circulation patterns of ocean currents make our planet inhabitable; about half of the oxygen in the atmosphere is derived from oceanic sources; and large sectors of the global economy depend on ocean-related commerce, including fisheries, tourism and shipping. People all over the world rely on the ocean for their basic caloric needs, and some coastal people obtain 100% of their animal protein from its waters. Regardless of where we reside, we depend on healthy ocean ecosystems and the services that they provide.



***The ocean
is the life
support
system for
our planet.***



CHANGING OCEAN – CHANGING CLIMATE

The ocean plays an integral part in influencing the global climate. Both regional and global climate patterns depend on long-term interactions between the ocean and the atmosphere: heat storage, transportation of heat around the globe, wind, evaporation and precipitation patterns, freezing and thawing in polar regions, and gas storage and exchange (including CO₂).

The ocean naturally buffers and equilibrates with the atmosphere. Changes in the ocean-atmosphere coupled climate system could have significant impacts on regional climate systems, including new current, wind, and precipitation patterns, affecting various local and regional processes on land.

The consistency of ocean currents keeps regions around the globe from experiencing large climatic and seasonal swings that they might otherwise experience. Instabilities in ocean currents caused by climate change could lead to major shifts in regional climate and weather patterns and potential human displacement.

Changing precipitation patterns will leave dry regions with even less rainfall, impede the replenishment of mountain glaciers and snow, and lead to intermittent destructive flooding interspersed with long, dry periods.

CLIMATE CHANGE INDUCED MIGRATION

People are already losing their homes to climate change. Sea-level rise and increased storm intensity will continue to force hundreds of millions of people to flee from low-lying delta areas and coastal and island nations. Some entire sovereign nations may become uninhabitable within the next 50 years. Small island states such as Tuvalu, Kiribati, and the Maldives lie less than one or two meters above current sea level. Increasing sea level and extreme weather events cause saltwater intrusion of soils and shallow freshwater supplies, triggering potentially severe health issues, rendering cultivation almost impossible and leading to considerable loss of property. In extreme weather events, some islanders are left with nowhere to hide. The relocation of entire communities is also occurring in the Arctic. Sea-level rise, reduced ice sheets, thawing permafrost, and increased coastal erosion are altering Arctic shorelines.





CLIMATE CHANGE IMPACTS ON HUMAN HEALTH

The impacts of climate change on human health are a primary concern. Direct stressors such as storm events, flooding, and severe winds can result in damage of private property, malfunctioning public sanitation systems, and saltwater intrusion into fresh water supplies. Furthermore, malnutrition and alterations to food habits can be expected when marine ecosystems and biodiversity change, especially in developing countries which rely on the ocean for basic caloric needs.

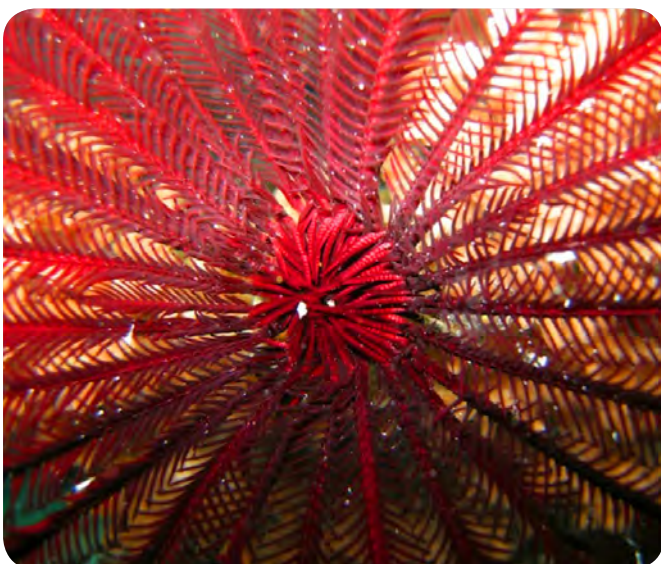
Ecosystem-based Adaption (EbA) is a strategy for reducing climate change impacts on human health. It is important to enhance the capacity of ecosystems to act as natural risk reduction mechanisms by restoring disturbed ecosystems, protecting natural buffers and reducing other human stressors. For example, protecting and restoring mangroves and coral reefs help reduce the impacts of storm events on coastal communities, and managing watersheds and wetlands supports natural water filtration.

More evidence is emerging that climate change has an impact on the frequency, duration and geographical range of infectious disease patterns and harmful algal blooms (HABs). Human exposure to toxins produced by HABs cause illness and can be fatal. Toxic algal incidents also negatively impact marine ecosystems and fish populations.



IN NUMBERS:

- The ocean covers more than 70% of the planet's surface.
- Less than 1% of the ocean is currently protected.
- It is estimated that 95% of the ocean remains unexplored.
- Thirteen of the world's 20 megacities lie along coasts and nearly 700 million people live less than ten meters above sea level.
- Fish provide nearly three billion people with at least 15% of their animal protein.
- Four hundred million people obtain more than half of their animal protein from fish and shellfish.
- It is estimated that by 2050, adverse effects associated with global climate change will result in the displacement of between 50 and 200 million people globally.
- The Arctic will be totally ice-free during the summer in less than 30 years.
- Ocean acidification has increased by 30% since the beginning of the industrial revolution and the rate of acidification is expected to accelerate in coming decades.
- Many of the currently remaining coral reefs may be lost to coral bleaching over the next 20 to 40 years.
- Seventy percent of known cold-water stony coral ecosystems will no longer be able to maintain calcified skeletal structures by 2100.
- Mangroves have been reduced to 30% - 50% of their historical cover.
- Land-based sources account for approximately 80% of marine pollution, globally.



THE NEED FOR IMMEDIATE ACTION

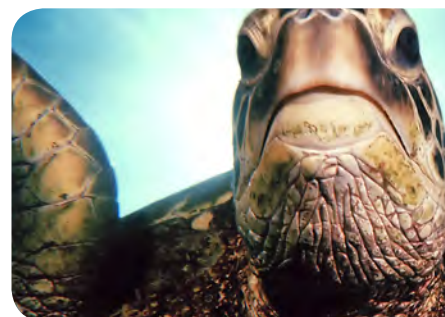
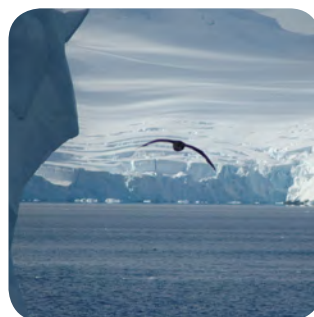
THE COSTS OF POLICY INACTION

Several studies have concluded that the economic damage resulting from future climate change will be much higher than the costs for current climate change mitigation and adaptation actions. Although it is extremely difficult to present exact economic numbers on the costs of inaction, they will be substantial.

Numerous reports outline the value that ocean economic activities (e.g. tourism and recreation, transportation, living and mineral resource extractions) contribute to national economies, foreign exchange receipts, government tax revenues and employment. In the U.S., for example, the ocean economy is responsible for the creation of over 2.3 million jobs and contributes over \$138 billion to the nation's GDP. The fisheries sector contributes more than 10% to the national GDPs of Cambodia, the Maldives and Kiribati.

Governments cannot afford to ignore proper management and conservation strategies or overlook nature-based solutions for climate change mitigation and adaptation. Investments in the management, conservation and protection of ecosystems and their services will not only help to build social resilience to climate change, but it will provide vast development returns by reducing poverty, strengthening livelihoods and supporting sustainable economic growth.

Investments in risk reduction strategies are within the commercial interests of private landowners and the tourism and insurance industries. Furthermore, projected additional impacts of climate change on fish populations should serve to warn the fisheries sector of the risk to the industry and the importance of conserving current stocks.



THE VALUATION OF ECOSYSTEM SERVICES

Despite the role of coastal and marine ecosystems in supporting economic development and social welfare, particularly in developing countries, current analysis of market activity does not consider all of these contributing factors. Indirect ecosystem services do not send price signals to markets and are therefore often not addressed in policy and business decisions that affect how ocean resources and services are used or misused.

While markets can capture some of the value of intact ecosystems, the loss of entire ecosystems due to climate change and other impacts are difficult to unambiguously and sufficiently calculate. When financing and implementing climate change mitigation and adaptation strategies, it is important to understand and demonstrate the dependence of world economies on healthy ecosystems, both in terms of their market and non-market values. Increased dialogue and collaboration amongst economists and natural scientists should be promoted, in order to provide more accurate policy-relevant valuation of ecosystem services.

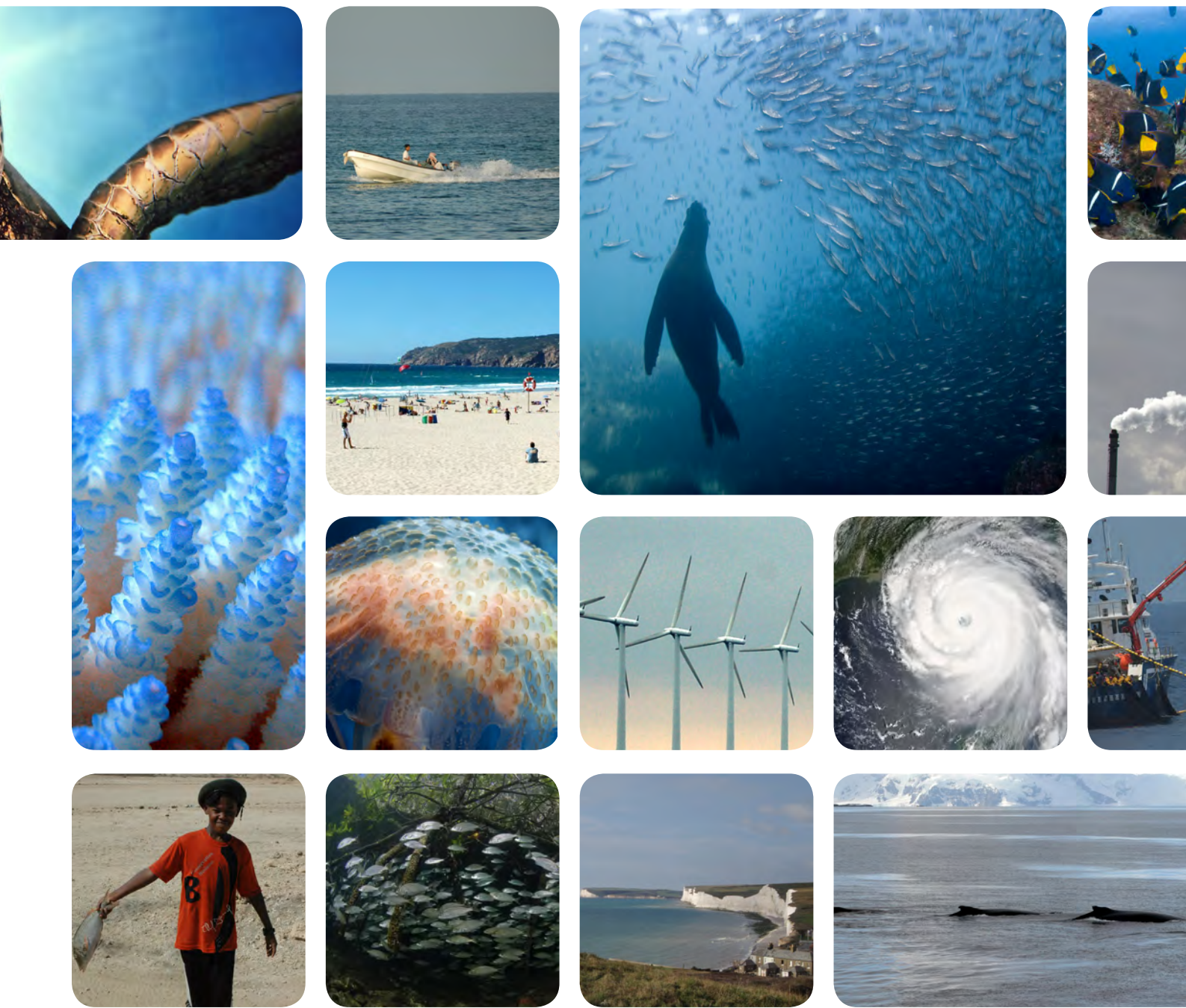


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DESIGN CREDITS:

Designed by Bradley Whitford at *Whitford Creations*. You can contact him at whitfobj@gmail.com or view his portfolio at www.BradWhitford.com.

An extended version of 'The Ocean and Climate Change –Tools and Guidelines for Action' supported by scientific references can be consulted and downloaded at

http://www.iucn.org/about/work/programmes/marine/marine_our_work/climate_change/publications.cfm

About IUCN

IUCN, the International Union for Conservation of Nature, helps the world find pragmatic solutions to our most pressing environment and development challenges by supporting scientific research; managing field projects all over the world; and bringing governments, NGOs, the UN, international conventions and companies together to develop policy, laws and best practices.

The world's oldest and largest global environmental network, IUCN is a democratic membership union with more than 1,000 government and NGO member organizations, and almost 11,000 volunteer scientists and experts in some 160 countries. IUCN's work is supported by over 1,000 professional staff in 60 offices and hundreds of partners in public, NGO and private sectors around the world. IUCN's headquarters are located in Gland, near Geneva, in Switzerland.

About the Global Marine Programme

Working alongside the world's leading marine experts, IUCN's Global Marine Programme brings forth science and new technologies for the sustainable management and conservation of marine ecosystems by connecting scientists, conservationists, private and public sector partners across its extensive network.

IUCN Global Marine Programme Thematic Areas

- Climate Change Mitigation & Adaptation
- Energy & Industry
- Securing Coastal Livelihoods
- Fisheries & Aquaculture
- Marine Protected Areas
- Ocean Governance
- Conserving Threatened Species
- Managing Marine Invasive Species

Further details and contacts

Further details on IUCN's work can be found at www.iucn.org

Further details on GMP's work can be found at www.iucn.org/marine/

If you have any additional enquiries, please contact:

Dorothee Herr dorothee.herr@iucn.org

Grant Galland ggalland@ucsd.edu

