UNEP

Regional Seas

Information Series

Technical analysis for policymakers on issues related to protection of the marine and coastal environment

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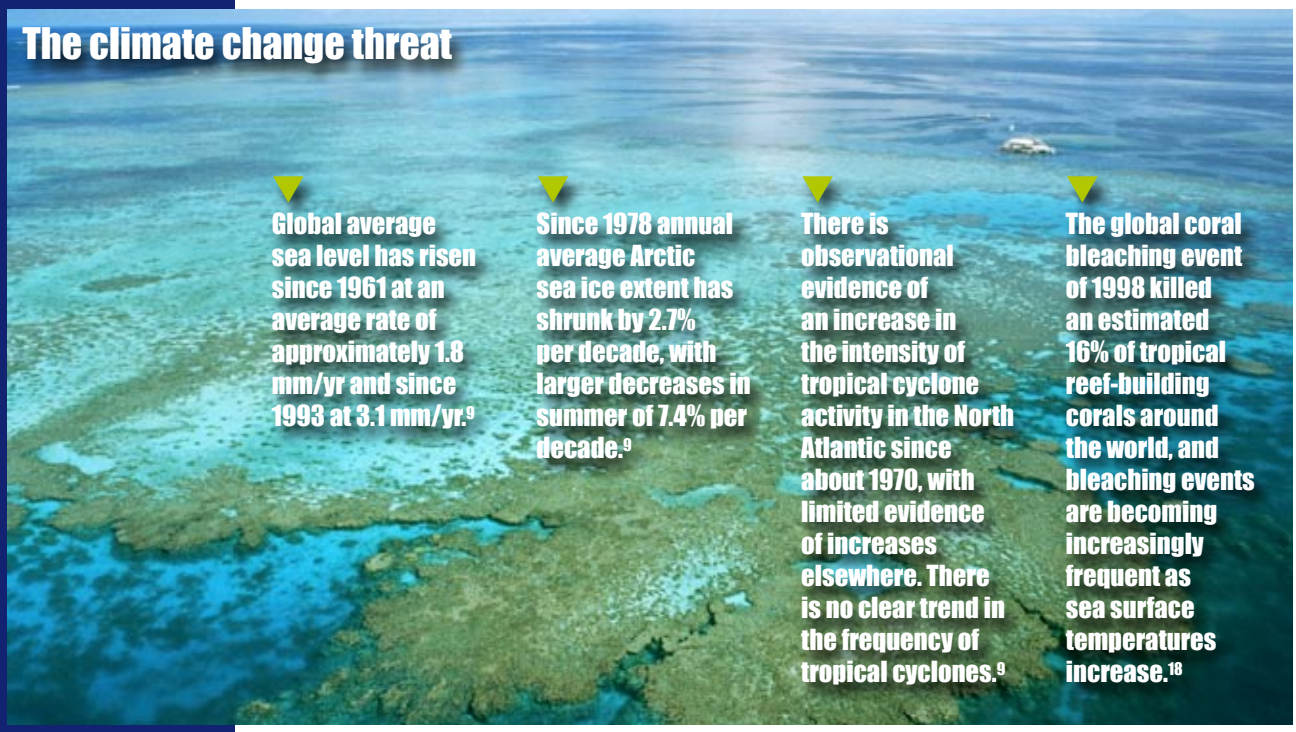
Using ecosystems to address climate change – Ecosystem based adaptation



Climate change is altering and damaging marine and coastal ecosystems around the world. Sea-level rise, erosion, the increased severity of storms and flooding, ocean acidification and coral bleaching are already causing devastation to coasts around the world. This affects the livelihoods ofpeople that depend on the services provided by these ecosystems, including food security, clean drinking water, medicines, recreational values and often the buffer that they offer to communities from extreme weather events. However, ecosystems need to be managed so that they continue to provide these important services and help coastal communities adapt to the impacts they face from climate change. Ecosystem-based management actions can help communities adapt to climate change, and are already an integral part of UNEP's Programme of Work.

Regional Seas Programmes can be effective platforms for promoting and facilitating ecosystem-based management and adaptation to climate change, given their regional mandate to effectively conserve and sustainably manage marine ecosystems for the benefit of their member countries.

Ecosystem-based management and restoration of ecosystems offer a valuable, yet often not fully recognized and therefore under-utilized approach for climate change adaptation which can replace or complement other adaptation actions like building expensive 'hard' infrastructure such as sea-walls and dykes. This approach, which values and uses ecological services and biodiversity, is also known as "Ecosystem-based Adaptation" (EbA).

Policy recommendations

1 It is recommended that governments consider ecosystem-based adaptation options as an integral component of disaster risk reduction and climate change adaptation strategies, as part of local and national development planning processes.

2 Climate change related projects should take into account the local environmental conditions and habitats and identify opportunities for maximizing ecosystem services for climate change adaptation and disaster risk reduction. Locally appropriate species should be used and not invasive species that can cause loss of biodiversity and habitat.

3 Local communities and stakeholders should be involved throughout the process to ensure well-designed, successful and sustainable ecosystem-based adaptation project and so as not to violate possible access rights.

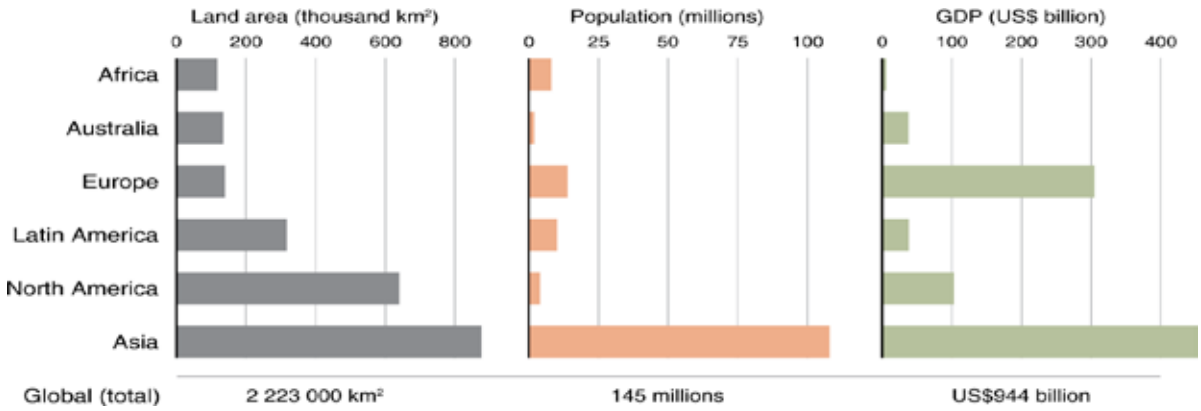
4 All ecosystem services should be valued (when practical) and recognized when assessing the cost-effectiveness of different adaptation options.

5 Sustainable coastal development that reduces physical exposure to natural and man-made hazards exacerbated by climate change, should be promoted.

6 Adequate disaster preparation plans, including early warning systems, community awareness and evacuation plans, should be used in conjunction with ecosystem-based adaptation actions as part of disaster risk reduction and adaptation strategies.

7 Resilience of social and ecological systems to natural and man-made hazards as well as to the impacts of climate change should be enhanced through improved ecosystem management and sustainable resource use.

8 Ecosystem-based adaptation is not the only solution, but is a long-term cost-effective approach that can be used in conjunction with other disaster management and climate change adaptation measures in order to reduce the vulnerability of coastal populations.



Populations, areas and economies affected by a 1 m sea level rise
(Global and regional estimates, based on today's situation).

Source: *Anthoff, D, Nicholls, RJ, Tol, RSJ and Vafeidis, AT. 2006. Global and regional exposure to large rises in sea-level: a sensitivity analysis. Working Paper 96. Tyndall Centre for Climate Change Research, Norwich.*

Even for today's socio-economic conditions, both regionally and globally, large numbers of people and significant economic activity are exposed to sea-level rise. The densely populated coastal megadeltas are especially vulnerable to sea-level rise. More than 1 million people living in the Ganges- Brahmaputra, Mekong and Nile deltas will be directly affected if current rates of sea-level rise continue to 2050 and there are no adaptation measures taken.

Benefits of ecosystem-based adaptation

Ecosystem management is a cost-effective adaptation strategy. For example, an investment of USD 1.1 million on restoring nearly 12,000 hectares of mangroves in Vietnam is estimated to have saved USD 7.3 million per year in dyke maintenance, while providing ecosystem services such as physical protection to coastal communities as well as productive fisheries[13]. Ecosystem-based adaptation strategies are accessible to rural communities and therefore offer the opportunity to use local, traditional and indigenous knowledge in adaptation. Technologies and methods are used that allow people and nature to adapt. They are also cheaper to implement and maintain than 'hard engineering' solutions such as sea-walls or dykes.

In addition to climate change adaptation, ecosystem management also provides many other benefits to local communities. These include ecosystem services that are crucial to people's livelihoods such as clean water and food security. Well-designed management schemes can also contribute to climate change mitigation by reducing carbon emissions from ecosystem loss and degradation as well as enhancing carbon sequestration.

However, valuable coastal ecosystems are being lost at an incredible rate. Mangroves, seagrasses and saltmarshes are being lost at a rate of 2-7% annually, a seven-fold increase compared to only 50 years ago[10]. The main reasons identified for habitat loss include unsustainable resource usage and harvesting, poor watershed management, poor coastal development practices and poor waste management in conjunction with storms surges that are increasing in frequency and intensity.

Management frameworks, guidelines and protocols exist to counter this negative trend in ecosystem degradation. However, awareness, enforcement and investment are often lacking in order to reverse the trend. It is crucial that countries become aware of their ecological values, invest in them and enforce management and protection policies.

case study

Wetlands in Mexico

The coastal wetlands of the Gulf of Mexico cover an area of more than 14,000 square kilometers. Here 27 major estuaries, bays, and coastal lagoons serve as shelter, feeding, and breeding areas for many species of valuable freshwater and marine fish. Moreover, these coastal wetlands play an important role in the local water cycle.

However sealevel rise in the Gulf of Mexico is leading to saltwater intrusion which is damaging the wetlands. Predicted changes in rainfall patterns will also affect natural drainage systems, further deteriorating these ecosystems. As these mangroves and marshlands degrade, they will have less capacity to withstand extreme weather events, and offer coastal populations less natural protection. However, the number of high-intensity hurricanes that have reached landfall in this area has increased by over 40 percent since the 1960s, and these storms often cause serious loss of property and human life with devastating ecological and economic consequences.

Today, the World Bank is implementing a project to address these concerns through improved water resource and wetland management. The project involves integrating climate change adaptation measures into resource management programs, restoring mangrove swamp ecosystems by establishing permanent and seasonal closed areas as well as by reducing and preventing changes in land-use, promoting more efficient water management, reintroducing native mangrove species in areas degraded by economic activities, maintaining water supply for production sectors and developing mechanisms to promote sustainable land use patterns that maintain the functional integrity of wetland ecosystems in the region.

If these measure can be successfully implemented and the wetland ecosystems can be protected and restored, then coastal populations will gain natural protection from hurricanes which is easy and cheap to maintain, as well as food security from fisheries and revenue from tourism.[14]

case study

Risk and Vulnerability Assessment Methodology Development Project in Jamaica

Coral reefs and seagrass protect 5.5% of Jamaica's GDP from sea-level rise and cyclone damage

The Jamaican government wanted to learn how ecosystem management could be used to reduce beach erosion in western Jamaica where 25% of all hotel rooms in Jamaica are located, accounting for approximately 5.5% of Jamaica's GDP. The Risk and Vulnerability Assessment Methodology Development Project (RiVAMP) is a pilot initiative implemented by the United Nations Environment Programme (UNEP). RiVAMP seeks to develop a methodology that takes into account environmental factors in the analysis of disaster risk and vulnerability, by recognizing ecosystems and climate change in the risk assessment process. The purpose of RiVAMP is to use evidence-based, scientific and qualitative research to demonstrate the role of ecosystems in disaster risk reduction and climate change adaptation, and thus enable policymakers to make better-informed decisions that support sustainable development through improved ecosystems management.

Jamaica was selected as the first country for the RiVAMP pilot. RiVAMP identified factors driving beach erosion and then modeled different future scenarios (with and without the reef, different sea level rise ranges, etc) and the impacts on the coastline. Based on statistical modeling and remote sensing, coral reefs explained or influenced 83% of the beach erosion, with the width of coral reefs playing the main role (59%) in reducing erosion. Furthermore, seagrasses explained 41% of the beach erosion, with the width of seagrasses playing the main role (47%) in reducing erosion. RiVAMP provided clear evidence of how coral reefs and seagrasses dissipate wave energy and therefore protect beaches from being further eroded. Based on stakeholder consultations, a set of ecosystem-based options were identified to reduce the rates of beach erosion as well as cope with future change scenarios. Results of the pilot have been presented to the government for further action. Here results have been presented to the government and are being taken up by policy-makers.

As a pilot initiative, the RiVAMP methodology is intended mainly for application in Small Island Developing States or coastal areas, and focuses on tropical cyclones and their secondary effects (coastal storm surges, flooding and strong winds). The long-term view is to develop related methodologies that can be applied in different eco-zones, namely mountains, river basins, low-lying deltas and drylands.[15]

Integrated Coastal Zone Management in Southern Africa

ICLEI – Local Governments for Sustainability –
Governance challenges for integrated management

Integrated Coastal Zone Management (ICZM) is a holistic approach that considers the entire spectrum of cross-sectoral uses, their impacts on ecosystems and the trade-offs needed to ensure sustainable development. More recently ICZM considers the impacts of climate change and adaptation responses. The main objectives that policy-makers should strive to attain are stakeholder participation, cross-sectoral and institutional integration leading toward long term sustainability and effective adaptation to climate change impacts.

The southern African coastline (Namibia, South Africa and Mozambique) is covered by mining concessions, ports and other coastal infrastructure, and is suffering from coastal erosion. Coastal management concerns arise from a lack of stakeholder participation, institutional frameworks, planning, human capacity and education in coastal areas. There are also problems at all levels of policy-making, from enactment to implementation, monitoring and enforcement, with a very poor record of compliance within environmental standards. The insufficient integration between different levels and sectors of governance is of serious concern for the effective implementation of ICZM and adaptation strategies.

Local governments in these three Southern African countries are working together with ICLEI – Local Governments for Sustainability to overcome these issues through actions on the ground. Local governments such as Walvis Bay (Namibia), Cape Town (South Africa) and Maputo (Mozambique) are prioritizing coastal zone issues that are integral to sustainability and future survival in the face of climate change. Examples can be seen in the movement toward understanding and modeling of the behaviour of storm surges and freshwater flooding by each of the cities and active rehabilitation of ecosystems. Given the current impacts that are already being witnessed (e.g. storm surges in Cape Town) such interventions will help build ecosystem resilience for ecosystem-based adaptation.

Mangroves in Vietnam

Planting mangroves saved USD 7.3 million in dyke maintenance

Vietnam is one of the most typhoon-struck countries in Asia. The Red River delta in the north coast of Vietnam is an extensive rice-growing and one of the most densely populated regions in the world. Here, local communities traditionally left a band of natural mangrove forest between dykes used for agriculture and the sea in order to help protect the rice fields from waves, wind and typhoon damage. However, the cutting of the mangrove forests for fuel and the spraying of chemical defoliants during the war in the 1970s destroyed most of this natural protection belt. As a result, erosion was an ongoing problem putting the people and their rice fields at risk from storms. The Vietnamese Red Cross working with local communities planted more than 175 km^2 of mangrove forest along almost 200 km of coastline, offering renewed protection from typhoons. A co-benefit from these efforts includes local communities harvesting marine products such as crabs and mussels in the replanted areas. The benefits of the project are significant. The planting and protection of 12,000 ha of mangroves cost around USD 1.1 million, but helped reduce the cost of dyke maintenance by USD 7.3 million a year. The Red Cross also estimates that 7,750 families improved their livelihoods, and hence their resilience to further hazards, through the selling of crabs, shrimps and molluscs.[13]

Coastal ecosystem-based adaptation options

(adapted from Hale et al, 2009) [7]

Adaptation option	Climate threats addressed	Additional management goals addressed	Benefits	Constraints
Allow coastal wetlands to migrate inland (e.g., through setbacks, density restrictions, land purchases)	Sea level rise	Preserve habitat for vulnerable species; Preserve coastal land/development	Maintains species habitats; maintains protection for inland ecosystems	In highly developed areas, there is often no land available for wetlands to migrate, or it can be costly to landowners
Incorporate wetland protection into infrastructure planning (e.g., transportation planning, sewer utilities)	Sea level rise; Changes in precipitation	Maintain water quality; Preserve habitat for vulnerable species	Protects valuable and important infrastructure	
Preserve and restore the structural complexity and biodiversity of vegetation in tidal marshes, seagrass meadows, and mangroves	Increases in water temperatures; Changes in precipitation	Maintain water quality; Maintain shorelines; Invasive species management	Vegetation protects against erosion, protects mainland shorelines from tidal energy, storm surge, and wave forces, filters pollutants, and absorbs atmospheric CO_2	
Identify and protect ecologically significant ("critical") areas such as nursery grounds, spawning grounds, and areas of high species diversity	Altered timing of seasonal changes; Increases in air and water temperatures	Invasive species management; Preserve habitat for vulnerable species	Protecting critical areas will promote biodiversity and ecosystem services (e.g., producing and adding nutrients to coastal systems, serving as refuges and nurseries for species)	May require federal or state protection
Integrated Coastal Zone Management (ICZM)—using an integrated approach to achieve sustainability	Changes in precipitation; Sea level rise; Increases in air and water temperatures; Changes in storm intensity	Preserve habitat for vulnerable species; Maintain/ restore wetlands; Maintain water availability; Maintain water quality; Maintain sediment transport; Maintain shorelines	Considers all stakeholders in planning, balancing objectives; addresses all aspects of climate change	Stakeholders must be willing to compromise; requires much more effort in planning
Incorporate consideration of climate change impacts into planning for new infrastructure (e.g., homes, businesses)	Sea level rise; Changes in precipitation; Changes in storm intensity	Preserve habitat for vulnerable species; Maintain/ restore wetlands	Engineering could be modified to account for changes in precipitation or seasonal timing of flows; siting decisions could take into account sea level rise	Land owners will likely resist relocating away from prime coastal locations
Create marsh by planting the appropriate species—typically grasses, sedges, or rushes—in the existing substrate	Sea level rise	Maintain water quality; Maintain/ restore wetlands; Preserve habitat for vulnerable species; Invasive species management	Provides protective barrier; maintains and often increases habitat	Conditions must be right for marsh to survive (e.g., sunlight for grasses, calm water); can be affected by seasonal changes
Use natural breakwaters of oysters (or install other natural breakwaters) to dissipate wave action and protect shorelines	Increases in water temperatures; Sea level rise; Changes in precipitation; Changes in storm intensity	Preserve coastal land/ development; Maintain water quality; Invasive species management	Naturally protect shorelines and marshes and inhibit erosion inshore of the reef; will induce sediment deposition	May not be sustainable in the long-term, because breakwaters are not likely to provide reliable protection against erosion in major storms
Replace shoreline armoring with living shorelines—through beach nourishment, planting vegetation, etc.	Sea level rise; Changes in storm intensity	Maintain/restore wetlands; Preserve habitat for vulnerable species; Preserve coastal land/development	Reduces negative effects of armoring (downdrift erosion); maintains beach habitat	Can be costly; requires more planning and materials than armoring
Remove shoreline hardening structures such as bulkheads, dikes, and other engineered structures to allow for shoreline migration	Sea level rise	Maintain sediment transport	Allows for shoreline migration	Costly for, and destructive to, shoreline property
Plant SAV (such as seagrasses) to stabilize sediment and reduce erosion	Changes in precipitation; Sea level rise	Maintain/restore wetlands; Preserve habitat for vulnerable species; Preserve coastal land/development	Stabilizes sediment; does not require costly construction procedures	Seasonality – grasses diminish in winter months, when wave activity is often more severe because of storms; light availability is essential

Potential losses in ecosystem services

Healthy ecosystems provide a wide range of services to coastal populations that can assist in adaptation to change. However these services are being degraded by human impacts such as pollution, overharvesting of resources and unsustainable infrastructure development; as well as increasingly by the impacts of global climate change. Preserving key ecosystem services can help people adapt to future climate variability and maintain livelihoods.

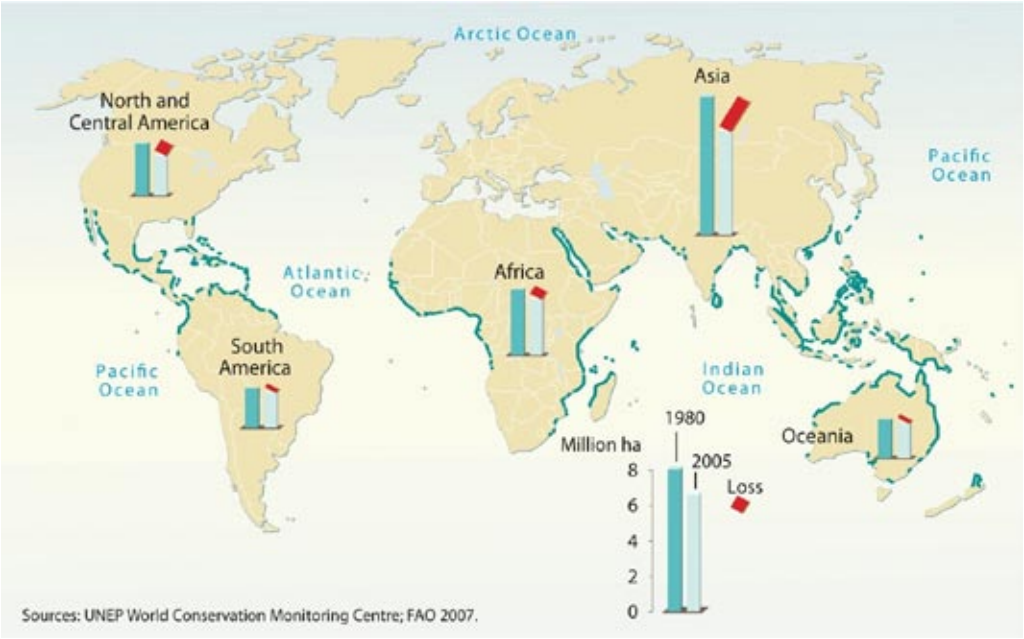
- Fish (including shellfish) provides essential nutrition for 3 billion people and at least 50% of animal protein and minerals to 400 million people in the poorest countries.[12]
- Over 500 million people in developing countries depend, directly or indirectly, on fisheries and aquaculture for their livelihoods.[12]
- Coral reef ecosystem services, including tourism, coastal protection and fisheries, are estimated to be worth 30 billion US$ per year.[2]
- 55% of atmospheric carbon captured by living organisms is captured by marine organisms, and of this between 50-71% is captured by the ocean's vegetated habitats (e.g. mangroves, salt marshes, seagrasses) which cover less than 0.5% of the seabed.[10]
- Recent studies in the Gulf of Mexico suggest that mangrove-related fish and crab species account for 32 percent of the small-scale fisheries in the region and that mangrove zones can be valued at $37,500 per hectare annually.[1]

With all the value that is provided by healthy ecosystems, and the fact that these values are being eroded by climate change, it is important to protect these important services in order to give people a better chance of adapting to change.

The world is losing its mangroves

Mangrove forests occur naturally in intertidal zones along sheltered shorelines and in deltas in tropical regions. They are vital breeding grounds for fish and shrimp and also provide a buffer against coastal hazards such as storms, cyclones, wind and salt spray by reducing wind and wave action. These values can help people adapt to climate change.

Source: UNEP World Conservation Monitoring Centre; FAO 2007.
Cartographer/Designer: Philippe Rekacewicz assisted by Cecile Marin, Agnes Stienne, Guilio Frigieri, Riccardo Pravettoni, Laura Margueritte and Marion Lecoquierre.



Case studies

References:

1. Aburto-Oropeza, O, Ezcurra, E, Danemann, G, Valdez, V, Murray, J, Sala, E. 2008. Mangroves in the Gulf of California increase fishery yields. Proceedings of the National Academy of Sciences of the USA 105, 10456-10459.

2. Cesar, H, Burke, L and Pet-Soede, L. 2003. The economics of worldwide coral reef degradation. Cesar Environmental Economics Consulting, Arnhem, 23 pp.

3. Convention on Biological Diversity 2009. Connecting Biodiversity and Climate Change Mitigation and Adaptation: Report of the Second Ad Hoc Technical Expert Group on Biodiversity and Climate Change. Montreal.

4. Dahdouh-Guebas, F., 2006. Mangrove forests and tsunami protection. In: 2006 McGraw-Hill Yearbook of Science & Technology. McGraw-Hill Professional, New York, 187-191.

5. FAO. 2008. The state of world fisheries and aquaculture. FAO, Rome.

6. Feagin, RA, Mukherjee, N, Shanker, K, Baird, AH, Cinner, J, Kerr, AM, Koedam, N, Sridhar, A, Arthur, R, Jayatissa, LP, Seen, DL, Menon, M, Rodriguez, S, Shamsuddoha, M and Dahdouh-Guebas, F. 2010. Shelter from the storm? Use and misuse of coastal vegetation bioshields for managing natural disasters. Conservation Letters 3, 1-11.

7. Hale, LZ, Meliane I, Davidson, S, Sandwith, T, Hoekstra, J, Spalding, M, Murawski, S, Cyr, N, Osgood, K, Hatziolos, M, Van Eijk, P, Davidson N, Eichbaum, W, Dreus, C, Obura, D, Tamelander, J, Herr, D, McClennen, C, and Marshall P. 2009 Ecosystem-based Adaptation in Marine and Coastal Ecosystems. Renewable Resources Journal 25, 21-28

8. Herr, D and Galland, G. 2009. The ocean and climate change: Tools and guidelines for action. IUCN, Washington DC, 71 pp.

9. IPCC. 2007. Fourth Assessment Report.

10. Nellemann, C, Corcoran, E, Duarte, CM, Valdés, L, DeYoung, C, Fonseca, L, Grimsditch, G. (Eds). 2009. Blue Carbon. A Rapid Response Assessment. UNEP, GRID-Arendal.

11. Osti, R, Tanaka, S and Tokioka, T. 2009. The importance of mangrove forest in tsunami disaster mitigation. Disasters 33, 203-213.

12. Partnership on Climate Change, Fisheries and Aquaculture. 2009. Fisheries and aquaculture in our changing climate. UNEP.

13. Reid, H and Huq, S. 2005. Climate change – biodiversity and livelihood impacts. Tropical forests and adaptation to climate change: in search of synergies. Adaptation to climate change, sustainable livelihoods and biological diversity, Turrialba, Costa Rica, March 2004., 57-70

14. The World Bank. (2010) Convenient solutions to an inconvenient truth: Ecosystem-based approaches to climate change. The World Bank, Washington DC, 114 pp.

15. UNEP. 2010. Linking ecosystems to risk and vulnerability reduction: The case study of Jamaica. UNEP, Geneva, 96 pp.

16. UNEP. 2005. After the tsunami: Rapid environment assessment. UNEP, 140 pp.

17. USAID. 2009. Adapting to coastal climate change: A guidebook for development planners. USAID, New York, 146 pp.

18. Wilkinson, C (ed). 2008. Status of the coral reefs of the world. GCRMN, Townsville, 298pp.

19. World Ocean Conference. 2009. Manado Ocean Declaration.

A global call for EbA

At the global level, ecosystem-based adaptation has been widely recognized as an essential adaptation strategy by the Manado Declaration of May 2009 that *'recognizes that healthy and productive coastal ecosystems, already increasing stressed by land-based and sea-based sources of pollution, coastal development, and habitat destruction, have a growing role in mitigating the effects of climate change on coastal communities and economies in the near term'* and *'recognizes that an integrated coastal and ocean management approach is a key in promoting resilience, and thus fundamental to preparing for and adapting to the effects of climate change on the ocean'*. The ministers and heads of delegations stressed *'the need for national strategies for sustainable management of coastal and marine ecosystems, in particular mangrove, wetland, seagrass, estuary and coral reef, as protective and productive buffer zones that deliver valuable ecosystem goods and services that have significant potential for addressing the adverse effects of climate change.'*

National policies should now reflect the commitments made at the World Ocean Conference of 2009.[19]

What are the potential policy implications?

While it is widely recognized that healthy and well-managed ecosystems are valuable for adaptation to climate change, there is now a need to put this understanding into practice. Building on the commitments to adaptation made by countries under the framework of the UNFCCC, adaptation through ecosystem management must be integrated into policy-making, planning and practical initiatives on the ground. At the policy and planning level, it is important to identify actions related to ecosystem management in National Adaptation Programmes of Action (NAPAs) and National Communications (for non-least developed countries), particularly at the local level, and to implement them. Considering that countries made this commitment to identify current vulnerability and adaptation needs at national level, there is therefore an urgent need to enhance the use of ecosystem management approaches in adaptation policy- aking and planning, from local and national to regional and international levels. And build these approaches into development policies and cross-sectoral planning. Capacity needs to be built to produce science that is relevant to and can drive policy. Furthermore, ecosystem assessments need to be designed so that they can be integrated into and inform sectoral adaptation options. It is advisable for governments to explore ecosystem-based options when planning for climate change adaptation on coasts, and to use ecosystems as a first line of defense before embarking on building infrastructure that is expensive to maintain and that often results in an increase in coastal erosion.

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The Regional Seas Conventions and Action Plans (RSCAPs) aim to address the accelerating degradation of the world's oceans and coastal areas through the sustainable management and use of the marine and coastal environments, by engaging neighbouring countries in comprehensive and specific actions to protect their shared marine environment. The Regional Seas Programme covers 18 regions of the world making it one of the most globally comprehensive initiatives for the protection of marine and coastal environment. The RSCAPs are important platforms for the implementation of the UNEP marine and coastal strategy, global conventions and MEA's. For more information please visit www.unep.org/regionalseas