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Coastal Ecosystems – Values and Services

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Coastal Ecosystems – Values and Services

The coastal zone is an area of highly dynamic and productive ecosystems. Coral reefs, mangrove forests, seagrass meadows and saltmarshes are among the most globally valuable ecosystems because of the range of ecosystem services they provide. Often occurring in close association to each other they sustain communities that live in their vicinity, business sectors and national economies. However, they are also highly vulnerable and at risk from development, overexploitation, physical alteration and destruction of habitat, as well as climate change related stress.

This paper examines coastal ecosystem services, values, threats, trends, and present activities of the United Nations Environment Programme (UNEP) in the context of the global policy framework and of the GPA source category of physical alteration and destruction of habitat (PADH). In this context UNEP encourages an ecosystem-based and integrated management approach¹ to marine and coastal ecosystems. Ecosystem-based management is a multi-sectoral approach that recognizes interactions within ecosystems (rather than focusing on single species) and between multiple human uses. Multiple human activities are thus managed for a common outcome, and human activities are managed in all the ways they interact with marine and coastal ecosystems.

The paper a) provides an introduction to coastal ecosystems and why they are of particular importance; b) presents the values associated with the multitude of services these ecosystems provide; c) explores the potential these ecosystems have for climate change mitigation through sequestration and storage of carbon; d) explores the opportunities these ecosystems offer for adaptation to climate change; and e) describes the global governance framework and relevant initiatives by UNEP.

A. Introduction to coastal ecosystems

The coastal zone is often densely populated because of the opportunities it generates for sustenance and economic development, including through access to marine and coastal resources, transport and trade. Fourteen of the 17 largest cities in the world are located on the coast and it is estimated that approximately 60% of the world's population lives within 100km of the seashore (World Resources Institute, 2000). Coastal ecosystems are an integral part of people's lives, providing services such as food security, protection from storms and flooding, clean water through nutrient filtration, and climate regulation through carbon sequestration and storage. However, due to multiple and synergistic anthropogenic threats, coastal ecosystems are being lost at an unprecedented rate.

Coral reefs

Tropical coral reefs, built by colonial coral animals, are among the most biodiverse systems on the planet, covering less than 0.1% of the ocean's surface but containing approximately 25% of all marine species. Approximately 850 million people live within 100 km of reefs and derive some benefits from coral reefs, with over 275 million depending directly on reefs for livelihoods and sustenance.

Coral reefs are also highly impacted by human activities. Of the world's estimated total reef area of 284,803 km², almost a fifth has already been lost (GCRMN 2008). More than 60 percent of the world's reefs are under immediate and direct threat from one or more local sources. Over-fishing and destructive fishing (e.g. using dynamite, poison or dragging nets, among other gear), affecting more than half of the world's reefs, is the most pervasive direct threat. Coastal development and watershed-based pollution, including eutrophication as a result land runoff also drive significant loss of coral reefs. These threats drive ecological changes to coral reefs, including cascading effects through the food chain, loss of coral cover, and ultimately phase shifts from coral-dominated to algal-dominated reefs and erosion of several key ecosystem functions and services, such as shoreline protection and food provisioning.

Coral reefs are also highly sensitive to increasing sea surface temperatures. Repeated coral bleaching (a coral stress response caused by above-average sea surface temperatures that can lead to mortality) has been recorded in most regions since the mass bleaching event of 1998, which caused an estimated 16% global mortality of coral reefs and mortality of up to 100% in some locations. Under a 'business as usual' scenario almost all coral reefs will experience thermal stress sufficient to induce severe bleaching every year by the 2050s. Ocean acidification is also believed to pose a growing threat to coral reefs, with implications for calcification and reef formation.

Climate change impacts on coral reefs exacerbate locally driven or watershed-based stresses. However, while tropical coral reefs are in a precarious situation, they also provide valuable indicators of environmental stress and global change, and are often dubbed the 'canary in the coalmine' for climate change. This makes them a flagship system for understanding how ecosystem and societal processes interact and adapt to climate change, and for predicting future change.

¹ http://www.unep.org/pdf/EBM_Manual_r15_Final.pdf

Mangrove forests

Mangroves are trees, shrubs, palms or ground ferns which grow above mean sea level in the saline intertidal zone, mainly between latitudes of 25°N and 25°S, with the largest extent and species diversity found between 5°N and 5°S (Spalding et al., 2010). They are a dominant feature of many tropical and subtropical coastlines, with tremendous social and ecological value. The products and services they provide include harvesting food, medicinal plants, wood for construction and fuel, they provide a nursery for commercially important fish and maintain shoreline integrity. The carbon sequestration and storage value of mangroves is also very high.

In the year 2000, the total area of mangroves was estimated at 137,760 km² (Giri et al., 2010). However, more than half of the world's original mangrove forest has disappeared (Valiela et al., 2001), with physical alteration and destruction of habitat a major driver. Conversion for shrimp and fish aquaculture, accounted for 20 to 50% of the total lost mangrove area worldwide in the decades leading up to the turn of the millennium (Primavera 1997). Over-exploitation of wood products, urbanization, and diversion of fresh water flow are other major drivers of degradation. Although some countries have halted and even reversed the loss of mangrove area through management and reforestation, mangroves remain under severe pressure from human activities in some parts of the world, including in South East Asia. The annual global rate of mangrove loss is presently between one and two percent (Spalding et al., 2010), and some projections suggest that mangroves in developing countries may decline by another 25 percent by 2025 (Ong and Khoon 2003).

Furthermore, mangroves are vulnerable to climate change. Changes in temperature, precipitation patterns, and extreme weather events will threaten mangrove health. However, sea-level rise is considered the greatest climate change threat to mangroves, leading to coastal squeeze where mangroves cannot migrate landward due to coastal infrastructure, urban developments or natural barriers. However, under some scenarios, where mangroves are well managed with sound hydrography and sediment supply, vertical accretion can keep up with rising sea-level.

Seagrass meadows

Seagrasses are flowering plants that thrive in shallow oceanic and estuarine waters around the world. Like terrestrial plants they have leaves, stems, rhizomes (horizontal underground runners) and roots. Seagrass ecosystem services support highly valuable commercially harvested prawns and fish, stabilization of sediments through root and rhizome systems and prevention of coastal erosion.

Found on every continent except Antarctica (Green and Short 2003), the global seagrass area has been estimated to exceed 177,000 km² (Green and Short 2003). The global area of seagrass beds has declined by almost a third in the last 100 years, and the rate of loss is estimated to have increased by an order of magnitude in the past 40 years. The main global drivers of this change are sediment loading and eutrophication, largely anthropogenic in origin. Eutrophication is particularly common in heavily developed parts of the world, leading to reduced water quality, poor light conditions and seagrass being outcompeted by overgrowth of macroalgae (Short et al. 1995). Sediment runoff into coastal waters associated with deforestation and mangrove-clearing have a strongly negative impact on seagrass through smothering and shading (Terrados et al. 1998, Duarte et al. 2008). Physical alteration and destruction of habitat, e.g. removal of seagrass by hotels (Daby 2003), by dredging and filling activities required for the building of causeways, docks and harbours and other infrastructure (e.g. Ruiz and Romero 2003, Hastings et al. 1995, Burdick and Short 1999), as well as trawling and other destructive fishing methods (Neckles and Short 2005) also cause loss of seagrass meadows.

The effects of climate change on seagrass meadows are uncertain. On the one hand, seagrass meadows may at least in some areas benefit from higher atmospheric CO₂ levels, which may have a direct positive effect on photosynthesis. Seagrasses are also not vulnerable to ocean acidification. On the other hand, seagrass may be negatively affected by increased sedimentation and turbidity caused by coastal erosion exacerbated by sea-level rise, and by increased terrestrial runoff in catchments where rainfall will increase as a result of climate change.

Saltmarshes

Tidal saltmarshes occur in the upper coastal intertidal zone between land and salt or brackish water, predominantly along protected coastlines with temperate climates. Dominated by salt-tolerant plants such as herbs, grasses and shrubs of terrestrial origin, saltmarshes provide a range of valuable ecosystem services, including support to fisheries, grazing or harvesting of fodder, and nutrient cycling. There is no detailed and consistent global inventory of salt marshes, and global area estimates made vary by an order of magnitude.

Saltmarshes are at risk of degradation and loss from a variety of human activities including reclamation of land for agriculture, building of dikes, nitrogen loading from land-based activities, sewage, urban and agricultural run-off, and industrial wastes. Globally, 25-50% of all tidal marsh area is estimated to have been lost due to human activity. The current annual rate of loss is estimated to be 1-2% (McLeod, et al. 2011). However the most pervasive threat to the remaining area of salt marsh is probably accelerated sea level rise (Fitzgerald et al. 2008; Nicholls et al. 1999). While moderate sea level rise may in some areas increase salt marsh area (e.g. Feagin et al 2010), increasing sea levels have

already placed marshes bordering steep slopes or on developed coastlines in a coastal squeeze (Doody 2004) as the ability of marshes to expand inland is severely restricted by urban development or infrastructure associated with land reclamation.

B. Coastal ecosystem services

The Millennium Ecosystems Assessment divides ecosystem services into four broad categories:

1. Regulating services (e.g. protection of beaches and coastlines from storm surges, wave action, floods and erosion; stabilization of coastal land; maintenance of water quality; sequestration and storage of carbon dioxide; waste processing; climate regulation),
2. Provisioning services (e.g. food; fuel; alternative energy; natural products; subsistence and commercial fisheries; traditional medicines)
3. Cultural services (e.g. tourism and recreation; spiritual appreciation; education; aesthetic value)
4. Supporting services (e.g. cycling of nutrients; soil, sediment and sand formation; photosynthesis; habitats for important biodiversity including commercially important species).

Ecosystem services provided by coral reefs, seagrass meadows, saltmarshes and mangroves are briefly reviewed below, with a synthesis of their economic values.

Coral reefs

Coral reefs are the most biodiverse marine ecosystem and safeguard the lives of hundreds of millions of people who depend on the natural services they provide – including food from fisheries, revenue from tourism and providing protection from extreme weather events. A square kilometre of healthy, well-managed coral reef can yield a catch of over 15 tons of fish and other seafood every year, with net annual benefit worth several hundreds of thousands of dollars. Coral reef biota also provides an important source of bioactive compounds for use in the development of medicines. A global study of the economics of coral reefs by Cesar et al (2003), concluded that coral reefs are worth up to 29.8 billion US\$ annually due to the services they provide. Tourism and recreation were calculated to be worth 9.6 billion US\$ per year (32.3% of total value), followed by coastal protection at 9.0 billion US\$ per year (30.2% of total value), fisheries at 5.7 billion US\$ per year (19.1% of total value) and biodiversity valued at 5.5 billion US\$ per year (18.4% of total value) globally. Ecosystem values that currently have an existing market (fisheries and tourism) are currently worth 51.4% of the total value (15.3 billion US\$) of coral reefs, while ecosystem values that currently do not have a market that rewards their protection (coastal protection and biodiversity) are worth 48.6% (14.5 billion US\$) of the total value of coral reefs. The total potential sustainable annual economic net benefits per km² of healthy coral reef in Southeast Asia is estimated to range from \$23,100 to \$270,000 arising from fisheries, shoreline protection, tourism, recreation, and aesthetic value (Burke, Selig and Spalding, 2002).

Mangrove forests

Mangrove ecosystem services translate directly into economic benefits for coastal communities, including by providing timber for construction and wood for fuel, a nursery and habitat for many harvestable marine species as well as non-timber forest products including medicinal plants, coastal protection by reducing waves energy, and water quality maintenance by filtering nutrients and trapping sediment. In Indonesia, the traditional use of mangrove products has been valued at over 3,000 USD per hectare per year, contributing up to a half of the income of the poorest households (IUCN, 2006). In Thailand, estimated benefits provided by mangroves, mostly to local communities, were around 584 USD per hectare for forest products, 987 USD per hectare for fisheries nurseries and 10,821 USD per hectare for coastal protection, giving a total value of 12,392 USD per hectare (Barbier, 2007). In Kenya, restoration of mangrove brought its total economic value to 2,903 USD per hectare per year including extractable wood products worth 379 USD per hectare per year, carbon sequestration worth 44 USD per hectare per year and coastal protection worth 1,587 USD per hectare per year (Kairo et al., 2009). In Belize, mangroves have been estimated to provide shoreline protection worth 111-167 million USD in avoided damages from extreme weather for the whole country (World Resources Institute). In Mexico, mangroves are estimated to support small-scale commercial fisheries worth 37,500 USD per hectare. In fact, fisheries production constitutes the major value of marketed natural resources from mangrove ecosystems. In 1997, annual commercial fish harvests from mangroves were valued \$6,200 per km² in the United States to \$60,000 per km² in Indonesia (Bann, 1997). Loss of mangrove reduces fisheries productivity. It has been estimated that, for every hectare of mangrove forest that is clear-cut, nearby coastal fisheries lose 670 kg in fish catch. (CRMP 1998).

Seagrass meadows

Seagrass goods and services have been estimated to be worth 19,000 USD per hectare per year (Costanza et al, 1997). A nursery for many commercially important marine species, the value of seagrass meadows for prawn fisheries in Queensland, Australia, has been estimated at 1.2 million AUD per year, equivalent to 1.2 million USD at time of writing. Another study calculated the seagrass meadows of the Bohol Marine Triangle in the Philippines to provide ecosystem goods and services worth 105,990 USD (Samonte-Tan et al., 2007). Many small-scale subsistence-fishing practices are entirely dependent on seagrass meadows, such as in some parts of Zanzibar, Tanzania (Torre-Castro and Rönnbäck 2004), and coastal populations in these areas receive most of their protein from fishing. Seagrasses are also used for their medicinal value, for building traditional houses, and as a food source. Another function of seagrass

meadows is their oxygenation of otherwise hypoxic sediments, which sustains high microbial activity and effective nutrient cycling in sediments. Furthermore, seagrass meadows trap nutrients and sediment, maintaining water quality, and they attenuate wave energy and thus protect coastlines from erosion.

Saltmarshes

Services provided by saltmarshes include support to coastal fisheries including by providing refugia for juvenile fish (e.g., Boesch and Turner 1984, Deegan et al. 2000), a source of food through subsistence as well as commercial harvesting, natural pasture for livestock or as source of fodder (Gallagher 1985), and protection from storm surges (Barbier et al. 2008, Morgan et al. 2009, Koch et al. 2009). One particularly important service is sediment trapping and reduced nutrient loading to coastal waters. However, nitrous oxide, a highly potent greenhouse gas, can be released from saltmarsh soils (Muñoz-Hincapié et al. 2002, Moseman-Valtierra 2011).

C. Coastal ecosystems, carbon and climate change mitigation

The climate regulation services of coastal ecosystems are becoming increasingly understood (Nelleman 2009). Mangroves, intertidal marshes and seagrass beds sequester atmospheric CO₂ through primary production, and deposit CO₂ in organic sediments. Because of high primary productivity and vast CO₂ reservoirs, these ecosystems are an important part of the global climate cycle and can play a part in mitigating climate change. The rates of carbon sequestration and storage are comparable to and often higher than rates in carbon-rich terrestrial ecosystems such as tropical rainforests or peatlands. Unlike most terrestrial systems, which reach soil carbon equilibrium within decades, deposition of carbon dioxide in coastal ecosystem sediment can continue over millennia. However, when degraded or destroyed these systems become significant sources of carbon dioxide emissions, due to oxidization of biomass and organic soil. The rate of emissions is particularly high in the decade immediately after disturbance, but continues as long as oxidation of sediment occurs (Duarte et al., 2005, Crooks et al 2011).

Mangrove Forests

The amount of carbon held in mangroves aboveground biomass is similar to terrestrial forests. However over 50% and as much as 90% of the total carbon stock in mangrove ecosystems lies in their organic-rich soils that range from 0.5 m to more than 3m in depth (Donato, *et al.* 2011.). Carbon accumulation in mangrove soils results largely from the burial of plant material but also from sediment accumulation from rivers, estuaries and the sea. Soils build vertically with sea-level rise, transferring soil carbon into long-term deep storage (McLeod et al, 2011). Accumulation rates are high, on average 829.42g CO₂ m⁻² yr⁻¹, and unlike terrestrial forests, mangrove soils can continue to sequester carbon for millennia. Consequently mangrove soil carbon stocks are very high, in the first meter of soils between 800 and 3,000 t CO_{2e}/ha (Sifleet, *et al.* 2011), making them among the most carbon-rich forests in the tropics (Donato, *et al.* 2011). Globally, the total carbon sequestration in mangrove soils is estimated to be between 114.137 – 126.248 Tg CO₂ yr⁻¹ (McLeod et al 2011). While the global total carbon held in terrestrial forests is higher due to their wider distribution, most of the carbon is held in biomass and there is little long-term accumulation of carbon in sediments (with the exception of peat forests). In comparison, the per unit area value of mangrove forests is considerable, in terms of carbon sequestration and storage as well as other ecosystem services such as fishery support, shoreline stabilization, protection from storms and water quality regulation. This offers opportunities to meet conservation, development, mitigation as well as adaptation targets.

When disturbed, mangroves release significant amounts of CO₂ due to oxidization of biomass and organic sediment. Recent measurements of CO₂ emissions from disturbed mangrove soils in Belize were 106 t CO₂ per ha per year in the first year, decreasing to 30 t CO₂ per ha per year 20 years after the mangroves were cleared (Lovelock et al, 2011). A study of mangrove forests in Malaysia shows that conversion to aquaculture ponds could result in the release of 550.5t CO₂ ha⁻¹ from removal of standing biomass and 2752.5t CO₂ ha⁻¹ from oxidization of organic sediments (McLeod et al, 2011). Global emissions resulting from mangrove deforestation and other land-use change are estimated at 0.0367 – 44.04 Tg CO₂ yr⁻¹ (Donato et al, 2011).

Saltmarshes

Between 95%-99% of the carbon stock in saltmarsh ecosystems is in the soil, which can extend to depths of several meters (Crooks et al, 2011). Estimates for carbon stock in the first meter of soil range between 900 and 1,700t CO_{2e}/ha (Sifleet et al, 2011). Saltmarshes show variable, but mostly high carbon burial rates per unit area, ranging between 66.06 – 6286.71g CO₂ m⁻² yr⁻¹ (McLeod et al, 2011). Global soil carbon sequestration by saltmarshes is estimated to be between 17.616 – 320.024 Tg CO₂ yr⁻¹ (McLeod et al, 2011).

Degrading or draining tidal marshes results in significant CO₂ emissions due to the oxidization of organic material. Emissions continue until the exposed carbon is depleted or until the original water level is returned and appropriate vegetation is restored (Crooks et al, 2011). Emissions from degraded tidal marshes are particularly high in the first decade after drainage and may continue for decades in more organic soils (Lovelock et al, 2011). In the Sacramento – San Joaquin Delta, California, USA, drainage of 1,800 km² of organic wetlands soils has released some 0.9 Gt CO₂

mostly over the last century (Crooks et al, 2011). Between 5 and 7.5 million tons of CO₂ continue to be released from this Delta each year, equivalent to 1–1.5% of the State of California’s annual GHG emissions, more than the annual emissions from a million cars on California’s roads.

Seagrass Meadows

Between 95% and 99% of the carbon in seagrass ecosystems is stored in the soil, which can reach 4 meters in depth (Mateo, 1997) and estimates of soil carbon in the first meter of seagrass meadows range between 66-1467 t CO_{2e}/ha (Murray et al, 2011). Carbon burial rates per unit area are high, on average 506.46g CO₂ m⁻² yr⁻¹ (Murray et al, 2011). The total global soil carbon sequestration by seagrass meadows is estimated to be between 176.16 – 411.0Tg CO₂ yr⁻¹ (Kennedy et al, 2010). The species *Posidonia oceanica*, which occurs in the Mediterranean, is the most studied seagrass species and is known to contain the highest content of soil carbon of all seagrass species studied to date. However, there remains uncertainty in our knowledge of the areal extent of seagrass meadows globally, the extent and permanence of seagrass carbon deposits, the fate of carbon transported to and from seagrass meadows, and our knowledge of possible greenhouse gas emissions from the physical alteration and destruction of seagrass habitats.

Coral Reefs

In spite of the vast calcium carbonate structures created by coral animals, coral reefs do not constitute a net carbon sink. The calcification process precipitates CaCO₃ from water but actually releases CO₂, rather than removing it from the atmosphere. Long-term deposition of organic carbon on reefs is negligible. This means that coral reefs do not offer the same opportunities for climate change mitigation as mangroves, seagrass meadows and salt marshes. They are, however, highly vulnerable to climate change, and can play a role in helping coastal communities and industries adapt to the effects of climate change.

D. Coastal ecosystems and adaptation to climate change

Coastal ecosystems are not only important for climate change mitigation, they can also be extremely valuable in helping coastal communities adapt to the threats of a changing climate. Where well managed and healthy, coastal ecosystems can act as buffers to climate-related threats such as rising sea level, shoreline erosion and increasing frequency and intensity of extreme weather events.

Using ecosystems for adaptation to climate change is dubbed ‘ecosystem-based adaptation’, and it can provide a cost-effective alternative or complement to hard engineering adaptation options. Traditionally, ‘hard’ engineering solutions such as sea walls are employed to protect coastal populations from these threats (for example, 13,600 square kilometres of the coastal zone in Europe are covered in concrete or asphalt, Airoidi and Beck, 2007). However, these engineering solutions are often expensive to build and maintain, and they can also increase erosion and change sediment transport so that more expensive infrastructure is needed in adjacent structures. Using ecosystems instead of or in conjunction with hard engineering options can have multiple benefits. They are cheaper to maintain and they provide a multitude of ecosystem services (as described above). For example, allowing wetlands to migrate inland will not only maintain their shoreline protection services, but could also directly address maintaining water quality and preserving habitat for maintaining local fisheries or tourism.

An analysis of recent disasters, including the December 2004 Indian Ocean tsunami and the hurricanes that struck North and Central America in September and October 2005, demonstrate the importance of coastal ecosystem protection in decreasing vulnerability to extreme events (Sudmeier-Rieux et al., 2006). In Vietnam, investment of \$1.1 million in the restoration and rehabilitation of 12,000 hectares of mangroves saved an estimated \$7.3 million a year through avoided sea dike maintenance, and significantly reduced the loss of life and property caused by Typhoon Wukong in 2000 compared with other neighbouring areas (IFRC 2002). In Malaysia, the value of intact mangrove swamps for storm protection and flood control has been estimated at 116,513 USD per kilometre, based on the cost of replacing them with rock walls (Ramsar Convention on Wetlands, 2005). FAO has stated that a broader mangrove belt could have reduced the impact of Typhoon Nargis, which struck the Ayeyarawady Delta in Myanmar in 2008 taking over 100,000 lives. Local communities are now replanting mangroves in the delta.

E. The global governance framework

The international governance framework relevant to coastal ecosystems includes several policy instruments, including two of the Rio conventions, the CBD and UNFCCC, as well the Regional Seas Conventions and Action Plans. Guidance and commitments are also contained within the outputs of the United Nations Conference on Sustainable Development (UNCSD), including Agenda 21 emanating from the Rio Conference in 1992, the World Summit on Sustainable Development Johannesburg Plan of Implementation (JPOI), and the outcome document and other possible commitments arising from the Rio+20 conference to be held in July 2012.

The below sections briefly review these policy instruments and relevant activities by UNEP. Perspectives for the further enhancement and implementation of the GPA intergovernmental mechanism are elucidated in document UNEP/GPA/IGR.3/3: Policy guidance for implementing the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities over the period 2012–2016.

UNCSD

Agenda 21² is a comprehensive action plan of the UN related to sustainable development and was an outcome of the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, in 1992. Agenda 21 was reviewed in September 2002 at the World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa where further actions and measurable targets for a plan of implementation were added. The purpose of the WSSD was to bring attention and focus on actions to address some of the world's most pressing issues related to livelihoods as well as the conservation of natural resources while demands from a growing human population are increasing. The main output from the WSSD was the Johannesburg Declaration of Sustainable Development³ and the Johannesburg Plan of Implementation⁴.

Marine and coastal issues were represented through two key targets: these include (1) the promotion of Integrated Coastal Management (ICM), which aims to assist with development of ocean policies and mechanisms on ICM; improvement of science and assessment of marine and coastal ecosystems; and promotion of sustainable tourism and (2) protection of coastal biodiversity through maintenance of productivity; provision of financial and technological assistance for capacity, especially in developing countries; development and facilitation of the use of different tools and practices to maintain diversity, including representative networks of marine protected areas by 2012 and elimination of destructive fishing practices; implementation of the Ramsar Convention and the International Coral Reef Initiative; and halting the loss of marine biodiversity by 2010.

The objective of the Rio+20 conference is to secure renewed political commitment for sustainable development, assess the progress to date and the remaining gaps in the implementation of the outcomes of the major summits on sustainable development, and address new and emerging challenges. The Conference will focus on two themes: (a) a green economy in the context of sustainable development and poverty eradication; and (b) the institutional framework for sustainable development.

UNEP Secretariat input to the compilation document for the Conference is available in the document "Secretariat of the United Nations Environment Programme Input to the Compilation Document for UNCSD"⁵ identifies a number of emerging challenges including in relation to marine resources, highlighting the need for urgent and systematic attention and for unifying the many pieces of policy and programmes and instruments that are in place at global, sub-regional and national levels, filling gaps as required. The document also identifies priorities related to *food and nutrition security, land, water and biodiversity resources and climate change*. A range of products on the Green Economy⁶ in the context of sustainable development and poverty eradication analyzing challenges and opportunities and identifying enabling conditions and policy options have also been developed.

The Convention on Biological Diversity

The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity; The sustainable use of the components of biological diversity; and The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

The second Conference of the Parties, held in Jakarta in 1995, adopted Decision II/10 called the 'Jakarta Mandate on the Conservation and Sustainable Use of Marine and Coastal Biological Diversity'. At the same occasion, the Ministerial Statement on the implementation of the Convention on Biological Diversity "*reaffirmed that there is a critical need for the Conference of the Parties to address the conservation and sustainable use of marine and coastal biological diversity, and urged Parties to initiate immediate action to implement the decisions adopted on this issue*".

The Jakarta Mandate highlights the vulnerability of coral reefs and Small Island Developing States and lays out the following principles – employing the ecosystem approach; employing the precautionary approach, valuing the importance of science, making full use of a roster of experts, involving and drawing upon knowledge of local and indigenous communities and implementation of the programme of work at local, national, regional and global levels. The elaborated programme of work, as contained in the annex to decision VII/5⁷, aims to assist the implementation of the Jakarta Mandate at the national, regional and global level. It identifies key operational objectives and priority activities within the five key programme elements, namely: implementation of integrated marine and coastal area management, marine and coastal living resources, marine and coastal protected areas, mariculture, and alien species and

² <http://www.un.org/esa/sustdev/documents/agenda21/english/Agenda21.pdf>

³ <http://www.un-documents.net/jburgdec.htm>

⁴ http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/WSSD_PlanImpl.pdf

⁵ http://www.unep.org/PDF/RIO20/UNEP_secretariat_input.pdf

⁶ www.unep.org/greeneconomy

⁷ <http://www.cbd.int/doc/decisions/cop-07/cop-07-dec-05-en.pdf>

genotypes. It also provides a general element to encompass the coordinating role of the Secretariat, the collaborative linkages required and the effective use of experts, as well as an element on enabling activities.

Among its provisions, the Jakarta Mandate ‘welcomes the International Coral Reef Initiative as a means to address threats to coral reefs and related ecosystems and encourages participation in International Coral Reef Initiative activities to implement its Framework for Action’ and it recognizes the United Nations Environment Programme as an ‘international body responsible for legal instruments, agreements and programmes which address activities relevant to the conservation and sustainable use of marine and coastal biodiversity’, and it invites UNEP to ‘review their programmes with a view to improving existing measures and developing new actions which promote conservation and sustainable use of marine biological diversity, taking into account the recommendations for action by the Parties to the Convention on Biological Diversity adopted by the Conference of the Parties at its second meeting, and provide information on their actions on a regular basis to the Conference of the Parties and, in a first instance, as soon as possible through the Executive Secretary. Furthermore, these various institutions are invited to cooperate with the Conference of the Parties through the Subsidiary Body on Scientific, Technical and Technological Advice in planning and implementation of programmes affecting marine and coastal biological diversity, so as to reduce any unnecessary duplication or gaps in coverage.’

Other CBD programmes are also of direct relevance to coastal ecosystems, such as the thematic programme on island biodiversity and several crosscutting programmes, including on climate change, invasive alien species, ecosystem approach, protected areas etc.

Aichi Biodiversity Targets

During the 10th meeting of the CBD Conference of the Parties in October 2010 in Nagoya, Aichi Prefecture, Japan, decision X/2 adopted a revised and updated Strategic Plan for Biodiversity, including the Aichi Biodiversity Targets⁸, for the 2011-2020 period. This new plan will be the overarching framework on biodiversity, not only for the biodiversity-related conventions, but for the entire United Nations system.

The 10th meeting of the Conference of the Parties agreed to translate this overarching international framework into national biodiversity strategies and action plans within two years. Additionally, in decision X/10, the meeting decided that the fifth national reports, due by 31 March 2014, should focus on the implementation of the 2011-2020 Strategic Plan and progress achieved towards the Aichi Biodiversity Targets.

There are five Strategic Goals⁹ related to mainstreaming; reducing direct pressures and promoting sustainable use; safeguarding ecosystems; enhancing benefits to all arising from biodiversity and ecosystem services; and enhancing implementation.

Within these strategic goals, several targets are specifically related to marine and coastal issues:

Target 6 - By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Target 8 - By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Target 9 - By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Target 10 - By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

Target 11 - By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Target 14 - By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Target 15 - By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

UNGA

Responding to a request in resolution 65/150 by the UN General Assembly, the Secretary-General of UN submitted a report¹⁰ on the “Protection of coral reefs for sustainable livelihoods and development” at the UNGA 66th session. The

⁸ <http://www.cbd.int/sp/targets/>

⁹ <http://www.cbd.int/sp/targets/>

report highlights the importance of protecting coral reefs and economic, social and development benefits of coral reef protection in the context of themes and objectives of Rio+20. A draft resolution “Protection of coral reefs for sustainable livelihoods and development”¹¹ for consideration at the 66th session of UNGA has been prepared by 20 countries, taking note of the aforementioned report and noting the opportunities provided by Rio+20.

Manado Ocean Declaration

The Manado Ocean Declaration¹² was signed at the World Oceans Conference in Manado, Philippines in May 2009 at a High Level Ministerial Meeting. The declaration strives to achieve long-term conservation, management and sustainable use of marine living resources and coastal habitats through appropriate of the precautionary and ecosystem approaches, and to implement long-term strategies in meeting the internationally agreed sustainable development goals, including those contained in the United Nations Millennium Declaration that are related to the marine environment, and in so doing will strengthen global partnership for development.

To support the attainment of the targets of the Manado Declaration, the United Nations has launched several initiatives to support governance and policy development, ecosystem-based management, and to coordinate governmental efforts to reverse degradation. Coral reefs and associated ecosystems have received considerable attention, and specific initiatives have been launched also for mangroves, seagrass beds and salt marshes.

F. UNEP’s work

The policy documents and mechanisms mentioned above provide the framework for the UN’s work on coastal ecosystems. In fulfilling its mandate to attain international goals and targets UNEP is further guided by the UNEP Medium Term Strategy and the UNEP Marine and Coastal Strategy. These strategies are operationalized through institutional and governance mechanisms, assessment and review, as well as a range of global and regional partnership initiatives relevant to coral reefs, mangroves, seagrass beds and salt marshes, described briefly below.

The Marine and Coastal Strategy

UNEP’s Marine and Coastal Strategy¹³ articulates the need for urgent action to maintain and rehabilitate marine and coastal resources. The vision - *prosperous and healthy oceans and coasts where conservation, productivity and resource use are sustainable* - will be achieved through work under four overarching objectives:

Land-Ocean Connections: to integrate the management of coastal watersheds, the coastal area (including cities) and the marine environment to optimize the ecosystem services and resilience of marine and coastal systems.

Ecosystems for Humanity: to identify, assess and value the status, key drivers of change and services of marine and coastal ecosystems and their link to human well-being.

Reconciling Use and Conservation: to ensure that appropriate governance frameworks, management tools, capacity and options are available for regions, countries, communities and the private sector to effectively engage in the sustainable management of marine and coastal ecosystems including reconciling competing uses.

Vulnerable People and Places: to strengthen the ecological, economic and social resilience of vulnerable communities and places including SIDS, including SIDS, to improve access and benefit sharing arrangements and to adapt and respond to natural disasters and climate change.

UNEP implements the Marine and Coastal Strategy through comprehensive assessments, developing legal instruments, strengthening the institutional and policy framework and capacity building initiatives.

Institutional and Governance Mechanisms

UNEP Regional Seas Programme

The Regional Seas Programme was launched in 1974 in the wake of the 1972 United Nations Conference on the Human Environment held in Stockholm. It aims to address the accelerating degradation of the world’s oceans and coastal areas through the sustainable management and use of the marine and coastal environment, by engaging neighbouring countries in comprehensive and specific actions to protect their shared marine environment. Today, more than 143 countries participate in 13 Regional Seas programmes established under the auspices of UNEP: Black Sea, Wider Caribbean, East Asian Seas, Eastern Africa, South Asian Seas, ROPME Sea Area, Mediterranean, North-East Pacific, Northwest Pacific, Red Sea and Gulf of Aden, South-East Pacific, Pacific, and Western Africa. Six of these

¹⁰ http://www.un.org/esa/dsd/resources/res_pdfs/ga-66/SG%20report_Coral%20Reefs.pdf

¹¹ <http://www.un.org/News/Press/docs/2011/gaef3328.doc.htm>

¹² <http://www.cep.unep.org/news-and-events/manado-ocean-declaration>

¹³ <http://www.unep.org/ecosystemmanagement/UNEPsWork/MarineandCoastalEcosystems/tabid/513/Default.aspx>

programmes, are directly administered by UNEP. Furthermore, 5 partner programmes for the Antarctic, Arctic, Baltic Sea, Caspian Sea and North-East Atlantic Regions are members of the RS family.

The Regional Seas programmes function through an Action Plan. In most cases the Action Plan is underpinned with a strong legal framework in the form of a regional Convention and associated Protocols on specific issues, including e.g. land-based activities, integrated coastal management. The work of Regional Seas programmes is coordinated by UNEP's Regional Seas Branch based at the Nairobi Headquarters. Regional Coordination Units (RCUs), often aided by Regional Activity Centres (RACs) oversee the implementation of the programmes and regional action plans.

UNEP Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA)

The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) was adopted by 108 Governments and the European Commission at an intergovernmental conference convened for this purpose in Washington, D.C., United States of America, from 23 October to 3 November 1995. It "aims at preventing the degradation of the marine environment from land-based activities by facilitating the realization of the duty of States to preserve and protect the marine environment". It is unique in that it is the only global initiative directly addressing the connectivity between terrestrial, freshwater, coastal and marine ecosystems.

The GPA targets major threats to the health, productivity and biodiversity of the marine and coastal environment resulting from human activities on land and proposes an integrated, multisectoral approach based on commitment to action at local, national, regional and global levels. The implementation of the GPA is primarily the task of Governments, in close partnership with all stakeholders including local communities, public organizations, non-governmental organizations and the private sector. Formulation of national and regional programmes of action is a necessity for successful implementation. UNEP, as the Secretariat of the GPA, and its partners will facilitate and assist Governments in their tasks. The Intergovernmental Review Meetings are a forum where Governments and other stakeholders meet to review the status of the implementation of the GPA and decide on action to be taken to strengthen the implementation of the GPA.

The UNEP Coral Reef Unit

In response to the global coral bleaching and mass mortality event in 1998, the UNEP Executive Director established the UNEP Coral Reef Unit on 1 December 2000, with the overall aims¹⁴ to: build consensus on actions to bring to sustainable levels the principal causes of coral reef decline; mobilize an international response, providing leadership in the UN system and the international community and promoting effective and coordinated efforts under global and regional multilateral agreements; and facilitate and encourage financing for coral reef projects. As of 2011 CRU operates under the Freshwater and Marine Ecosystems Branch of DEPI, hosted by the UNEP Regional Office for Asia and the Pacific located in Bangkok, Thailand.

The Coral Reef Unit is a vehicle for implementation of the UNEP Marine and Coastal Strategy with particular attention to coral reefs, and the communities and industries that depend on them, including through development and strengthening of the coral reef programmes of Regional Seas Conventions and Action Plans, and working through global and regional initiatives and partnerships.

The UNEP World Conservation Monitoring Centre (UNEP-WCMC)

UNEP-WCMC is UNEP's specialist biodiversity assessment arm. Their mission is to evaluate and highlight the many values of biodiversity and put authoritative biodiversity knowledge at the centre of decision-making. WCMC's goal is to provide authoritative, relevant and timely information for countries, MEAs, organizations and companies to use in the development and implementation of their policies and decisions. UNEP-WCMC supports the marine and coastal work of the UNEP by providing high quality data sets and analyses, for example through the Ocean Data Viewer.

UNEP/GRID-Arendal

GRID-Arendal is an official UNEP collaborating centre, supporting informed decision making and awareness-raising through: Environmental information management and assessment; Capacity building services; and Outreach and communication tools, methodologies and products.

The GRID-Arendal Marine Programme supports the marine and coastal work of the UNEP through capacity building and assessment initiatives, the Marine Programme promotes responsible and sustainable management of the oceans and coasts by addressing issues of sovereignty, resource management and protection of the marine environment also in the context of climate change. The UNEP Shelf Programme, a component of the Marine Programme, assists developing states in completing the activities required to establish the outer limits of their continental shelves according to Article 76 of the United Nations Convention on the Law of the Sea (UNCLOS).

¹⁴ 'Objectives and Strategy for the Coral Reef Unit' 16 May 2002.

Assessment and review

The Global Environmental Outlook

The UNEP Global Environment Outlook (GEO) project was initiated in response to the environmental reporting requirements of Agenda 21 and to a UNEP Governing Council decision of May 1995 which requested the production of a new comprehensive global state of the environment report. It includes regional chapters on marine and coastal ecosystems written by a working group of experts. Four GEO reports have been published to date: GEO-1 in 1997; GEO-2000 in 1999; GEO-3 in 2002; and GEO-4 in 2007. GEO-5 is currently under production¹⁵. Other notable reports in the leadup to Rio+20 include “Keeping Track of our changing environment: From Rio to Rio+20 (1992-2012)”¹⁶ as well as an assessment report entitled “Progress Towards Meeting Internationally Agreed Goals”¹⁷ (Pre-Publication: Findings from GEO-5 Draft).

The World Atlas of Mangroves, the World Atlas of Coral Reefs, the World Atlas of Seagrass

Through the UNEP World Conservation Monitoring Centre and in collaboration with UNESCO, FAO and other organizations, UNEP has contributed to developing the most comprehensive atlases of critical coastal ecosystems to date. In 2001, UNEP contributed to the World Atlas of Coral Reefs, in 2003 to the World Atlas of Seagrasses, and in 2010 the World Atlas of Mangroves. These atlases present a baseline global inventory of coastal ecosystems using current knowledge.

Global and regional partnerships

The International Coral Reef Initiative and its Networks

The establishment of the International Coral Reef Initiative (ICRI¹⁸) was announced at the First Conference of the Parties of the Convention on Biological Diversity in December 1994. Founded by eight governments, Australia, France, Japan, Jamaica, the Philippines, Sweden, the United Kingdom, and the United States of America, ICRI is a partnership among governments, intergovernmental organizations, development organizations, donors, non-government organizations and the private sector, striving to preserve coral reefs and related ecosystems, such as mangroves and seagrass beds by implementing Chapter 17 of Agenda 21 and other relevant international conventions and agreements. UNEP is an ICRI member since its inception.

ICRI advocates international recognition that coral reefs are in serious decline globally due primarily to human activities, focusing on mobilising governments and a wide range of other stakeholders around a political "Call to action", a consensus framework for achieving sustainable management of coral reef ecosystems. ICRI fosters improved management practices and capacity building, research and monitoring, the sharing of information, and fund raising, in order to preserve the biodiversity and ecosystem services of coral reefs as a building block for sustainable development. The global network of Regional Seas Conventions and Action Plans, most of which are administered by or established through UNEP, are recognized as a key implementation mechanism for ICRI.

Operational networks established under the ICRI include the Global Coral Reef Monitoring Network (GCRMN) and the International Coral Reef Action Network (ICRAN)

The Global Coral Reef Monitoring Network (GCRMN¹⁹) is the world's foremost global initiative dedicated to monitoring the status of coral reefs. Established in 1994 as a network under ICRI, GCRMN releases periodic global status reports (1998, 2000, 2002, 2004, 2008, with a report under preparation for 2012). Thematic reports address specific issues, including a detailed report on the Caribbean bleaching in 2005. The Status of Coral Reefs in East Asian Seas report 2010 includes a regional overview of severe bleaching in 2010. A Pacific Coral Reef Status and Outlook report will be released in early 2012. The GCRMN SocMon initiative has developed methodological guidance for socioeconomic assessment of coral reef areas, including the implications of bleaching, and conducted assessments through regional networks. A GCRMN study underway, entitled “Enhancing the Management Relevance of Reef Monitoring in a Changing World” aims to guide future monitoring in assessing climate change impacts and generating recommendations for management and development. UNEP serves on the GCRMN Management Group and administers funding for global coordination of GCRMN.

¹⁵ <http://www.unep.org/GEO/>

¹⁶ http://www.unep.org/GEO/pdfs/Keeping_Track.pdf

¹⁷ <http://www.unep.org/pdf/RIO20/progress-internationally-agreed-goals.pdf>

¹⁸ www.icriforum.org

¹⁹ www.gcrmn.org

The International Coral Reef Action Network (ICRAN²⁰) was a partnership project established as a network under ICRI and administered by UNEP from 2000 to 2010. Through a grant from the United Nations Foundation (UNF) and a broad range of other contributing donors, ICRAN provided a means for consolidating technical and scientific expertise in reef monitoring and management to create strategically linked actions across local, national and global scales. An innovative and dynamic network of many of the world's leading coral reef science and conservation organisations, ICRAN was the first alliance to respond to conservation needs at the global scale by recognising both traditional and scientific perspectives of coral reef dynamics and social dependency. Over one decade ICRAN leveraged over USD 15 million towards sustainable coral reef management worldwide.

Mangroves for the Future

Mangroves for the Future (MFF) is a partnership-based initiative promoting investments in coastal ecosystems that support sustainable development. MFF builds on a history of coastal management efforts before and after the 2004 Indian Ocean tsunami. MFF seeks to achieve demonstrable results through regional cooperation, national programme support, private sector engagement and community action. Although MFF has chosen mangroves as its flagship ecosystem, the initiative embraces all coastal ecosystems, including coral reefs, estuaries, lagoons, wetlands, beaches and seagrass beds. Its management strategy is based on specific national and regional needs for long-term sustainable management of coastal ecosystems. These priorities, as well as newly emerging issues, are reviewed regularly by the MFF Regional Steering Committee to ensure that MFF continues to be a highly relevant and responsive initiative. UNEP is a partner in MFF.

G. Future Implementation of the GPA

The report “The State of the Marine Environment – Trends and processes”²¹ prepared for the 2nd GPA IGR meeting in 2006, identifies progress in addressing several GPA pollutant source categories, but also notes that conditions have worsened for sewage, nutrients, marine litter, and physical alteration and destruction of habitats (PADH):

“Physical alteration and destruction of coastal ecosystems has continued to increase in the last decade as a direct result of population growth and associated growth in economic and development activities, in particular those associated with infrastructure and tourism. Coastal ecosystems and habitats, particularly wetlands, mangroves and coral reefs, are fast disappearing; this in turn affects biota, with grave consequences for bio-diversity and food supplies. While deterioration is worst in regions with the fastest rates of population growth, no area is spared. An emerging factor is the growing incidence of catastrophic natural events, sometimes exacerbated by previous weakening of natural systems brought about by human action.”

As described in the sections above coastal ecosystem status and trends continues to be of considerable concern, especially in view of development trajectories, effectiveness of management and climate change. However, opportunities in terms of new and emerging scientific findings, development of tools and approaches, and continued strengthening of policy and governance frameworks offers some opportunities to safeguard coastal ecosystem health and services.

Some future perspectives for the GPA in this regard are provided in the document UNEP/GPA/IGR.3/3: Policy guidance for implementing the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities over the period 2012–2016.

²⁰ www.icran.org

²¹ http://www.gpa.depiweb.org/docman/doc_download/178-state-of-the-marine-environment-trends-and-processes.html