

Monitoring and Managing for Climate Change in Vulnerable Oceans and Coastal Ecosystems, and Integrating Results into Policy Responses

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The world's coasts and oceans are vulnerable ecosystems and important indicators of climate change. These ecosystems are diverse, including Arctic coasts, tidal rivers, estuaries, deltas, lagoons and enclosed seas, tropical and deepwater corals, and seamounts. Vulnerable ecosystems can assist in understanding the effectiveness of adaptation and mitigation strategies for climate change. Climate change is very pressing in the Arctic, as documented in the Arctic Climate Impact Assessment Scientific Report, but also relevant for Europe and globally. Despite apparent differences, there are significant and parallel sensitivities to climate change across diverse vulnerable coastal and marine ecosystems, which support the sharing of information and management approaches across all these ecosystems.

Further global and regional linkages are required across these vulnerable areas to respond to climate impacts on oceans and coasts. The United Nations Environmental Program has focused on two vulnerable regions, the Arctic and Small Island Developing States, to publicize effects of climate change and to develop a joint project for develop adaptation strategies. Other links are also required. The Third Global Conference can provide an opportunity to draw links between ecosystems and climate change in other regions of the world, to bridge the divide between developing and developed countries, and to develop a shared understanding and information and adaptive management approaches. Given the increasing frequency of severe storm events, such as Hurricane Katrina, it would be useful to develop emergency responses to climatically influenced storm events.

Lessons can be drawn from existing global and regional efforts. Two global initiatives are highlighted. The Millennium Ecosystem Assessment Synthesis Report, which included coastal and marine environments, found ongoing degradation of fifteen of the twentyfour ecosystems, increasing the likelihood of abrupt changes, and warned that the harmful consequences of degradation could significantly increase in the next fifty years. This included the emergence of new diseases, sudden changes in water quality, creation of dead zones along the coasts, the collapse of fisheries, and shifts in regional climate. The Global Oceans Observing Systems or GOOS is the oceans component of the Global Climate Observing System, and provides information about the present and future states of the seas and oceans, their living resources, and the role of the oceans in climate change, thus providing the information to enable national, regional and international responses to climate change.

The circumpolar arctic is a region with assessment of, and monitoring and management responses to climate change. The Arctic Council and Member States have adopted policy measures to respond to the Arctic Climate Impact Assessment Scientific Report. The Circumpolar Biodiversity Monitoring Program is being implemented by the Conservation of Arctic Flora and Fauna Working Group, in cooperation with other Arctic Council Working Groups and Member States. Among other matters, the program will monitor for climate change in coastal and marine areas, and thus support national and regional policy responses.

Europe is leading with innovative adaptive and mitigative measures for climate change, including measures for coastal and marine ecosystems. European policies, and adaptation and mitigation strategies occur under the European Climate Change Program, and through such initiatives as the Water Framework Directive, and the draft Maritime and Marine Strategies. European efforts also extend to shared marine areas such as the Atlantic Ocean, North Sea, and the enclosed Mediterranean and Baltic Seas.

Impacts of climate change are already apparent for ecosystems in the Arctic and Europe. The Canadian Beaufort Sea, the Thames River, the central coastal region of Portugal, and the

Venice Laguna are briefly reviewed below. These ecosystems illustrate the impacts and vulnerabilities to climate change in various regions seas: the Arctic Ocean, the North Sea, the southern Atlantic, and the Adriatic and Mediterranean Seas. The ecosystems show the complex interactions between the local environment, human occupation and use, and climate impacts in that ecosystem. Last, the ecosystems demonstrate the relationship between the rivers and the coasts, the impact of the larger regional sea,, and the need for monitoring and management solutions that incorporate freshwaters and marine waters, often in the overall context of regional seas.

The Beaufort Sea is one of the five designated Large Ocean Management Areas in Canada. The Mackenzie River enters the Beaufort Sea, and it is an area of high biological productivity, including ice edge dependent species like beluga whales, polar bears and seals. The Beaufort Sea is a hot spot for climate change, and impacts include receding multi-year ice, later freezing and earlier melting of ice, and greater coastal erosion. The Beaufort Sea Partnership is a government, stakeholder and Inuvialuit initiative to develop integrated management plans for the area. Recommended coastal and offshore management boundaries reflect the shifting multi-year ice edge and include freshwater flows. Monitoring and management will reflect the climate impacts on this region, which are of concern to local residents, government and scientists.

The UK has a vulnerable coastline with many tidal rivers. The Thames River is tidal through much of London, and experiences significant flood risk through its freshwater flows, and through tides and storm surges from the North Sea. The Environment Agency is implementing the Thames Estuary 2100 to assess present and future flood defences for the Thames River and the estuary. Floodscape is an EU project led by the Environmental Agency that examines three scenarios in the Thames estuary to understand and communicate flood risk to stakeholders, and to develop adaptive strategies that include acceptance of flood risk and controlled flooding.

Portugal experiences significant risk from climate change through changing precipitation patterns, high temperatures and forest fires. Additionally, Portugal has the most extensive Exclusive Economic Zone in Europe, and thus a greater range of oceans ecosystems subject to climate change. Coastal erosion and sea level rise is also a threat in central Portugal. Much of the central coast is low and exposed to dynamic waves, winds and tides from the Atlantic Ocean. The rates of coastal erosion are high, due to construction of coastal defences and ports, and changes in rivers and sediment deposit. Erosion will increase due to climate change. Coastal planning in Portugal is limited to a narrow coastal and offshore strip, does not include upstream rivers or harbour areas, and is not likely to fully address climatic changes.

The Venice lagoon indicates the exceptional vulnerability to sea level rise and storm events of the historic city of Venice, the modern port of Maghera, and the largely enclosed salt water lagoon. The key problem is the greater frequency of floods due to increased relative sea level. Enlargement of inlets and dredging of the navigation channels has made the lagoon more sensitive to sea level rise and increased frequency of flooding, so even a minor increase in sea level is problematic. In response, extensive flood defences have been approved for the Venice lagoon. The Modulo Sperimentale Elettromeccanico is a system of mobile dikes and floodgates that has been approved for the three ports. Over time, complete enclosure of the lagoon from the Adriatic Sea may have to be considered, but this will affect the water quality and ecology of the lagoon.