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## Summary on Major Ecosystem Services

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**Opposite page:** Waterfront of Lamu old town, Kenya. © Kiunga Kareko.

Part IV dealt with ecosystem services from the coastal and marine environment, as opposed to goods. Whereas ecosystem goods have been widely discussed in literature due to their direct benefits to humans, services (e.g., critical buffering, regulating and life-supporting services or processes) are commonly forgotten or taken for granted. Ecosystems also provide less tangible benefits such as recreational, aesthetic, cultural and spiritual values that are important in fulfilling people's emotional and psychological needs.

**The ocean's role in the hydrological cycle** is critical in sustaining life on earth, because it influences the process of water circulation and exchange. This inert ability of global oceans stem from their coverage of 70% of earth's surface, and the higher heat exchange capacity of water, than land and atmosphere. Almost half of the absorbed solar energy at the sea surface is released back into the atmosphere as vapour – this eventually forms clouds that bring rain, thus completing the hydrological cycle on which life on earth depends. Global warming disturbs the balance, by melting polar ice caps and glaciers, and releasing water into the oceans, causing a rise in sea level. Hence, future inundation of low-lying coastal areas is expected, with implications for infrastructure (e.g., coastal developments or cities), agriculture, trade and tourism. It is forecast that the greatest impact will be on the economies and livelihoods of the developing world (Dasgupta et al. 2009), such as the SW Indian Ocean.

Gaseous exchange at the **sea/air interface** is irregular,

and depends on sea surface layer dynamics and mixing, driven by solar radiation, wind and waves. This exchange affects biogeochemical processes, weather and climate, through causing fluctuation of physical and chemical properties. If the sea/air interaction processes remained unchanged, a dynamic balance between the concentrations of CO<sub>2</sub> in the atmosphere and in the ocean would be maintained. However, rising atmospheric concentrations of CO<sub>2</sub> also increases its level in sea water, thus leading to ocean acidification, with major negative implications for calcifying organisms, marine ecosystem functioning and ultimately food security.

**Phytoplankton primary production** forms the basis of oceanic food webs, on which marine ecosystems rely. Phytoplankton productivity is governed by photosynthesis and largely depends on levels of light, temperature, nutrients and CO<sub>2</sub>. Principal drivers of primary productivity in the Indian Ocean are monsoon seasons, ocean circulation, upwelling and eddies, irradiance and water temperature. Reduced primary production in the region would cascade through the trophic levels, producing less fish for capture. Conversely, elevated primary production may cause harmful algal blooms (HABs), with implications on food safety, human health, and income-generating activities.

**Production of ocean-based carbonates** drives the calcification process that builds coral reefs and supplies carbonate sands to coastal lagoons and beaches. Worldwide, calcium carbonate (CaCO<sub>3</sub>) from corals and calcifying algae is the greatest source of biogenic sediments in

the oceans. Major anthropogenically induced threats to carbonate producers are acidification and coral bleaching (exacerbated by climate change), eutrophication (influences habitat structure) and poor land-uses (enhances sedimentation) which enhance bioerosion and disease prevalence.

Important **aesthetic, cultural, and spiritual services** are also derived from Western Indian Ocean coastal and marine environments. Some sites attract significant tourism because of these values, for instance iSimangaliso Wetland Park (South Africa) and Lamu Old Town (Kenya). In some cases, historical sites and landscapes have suffered from poor management, or physical intrusion. Equally important are traditional knowledge systems and institutions, such as *Kayas* in Kenya and *Dina* in Madagascar. Such systems illustrate the existence of customary resource management methods, or a traditional understanding and appreciation of ecosystem functioning.

## RECOMMENDATIONS

Key recommendations under this Part IV include:

**Holistic ecosystem services valuation:** Ecosystem services are often ignored in management planning, hence only goods having direct human benefits get considered. It is recommended that services e.g. supporting, regulating and cultural (including aesthetic and spiritual) should be integral in planning considerations. It is also important to invest in wholesome economic valuation of ecosystem services to inform policy/development decisions. This is critical, pending the future of coastal areas as major economic development corridors.

**Blue economy approach:** It is important that governments comprehensively integrate blue economy principles, to minimize environmental impacts of new developments. Planning tools e.g. SEA, marine spatial planning and Integrated Ocean Management (IOM) should be applied to safeguard ecosystem services.

**Knowledge integration:** Local communities have sustainably managed their natural resources for millennia. Degradation thereof often follows on from external interference, including population growth. It is therefore important that traditional management systems are integrated with modern management systems. This might include recognition in law.

**Investment in research to address gaps:** There is an established positive correlation between the level of investment in research by countries and corresponding level of development. Research gaps include valuation of ecosystem services; productivity trends; status of traditional management systems; and climate change vulnerability and mitigation.

**Environmental awareness:** People will appreciate, manage and conserve what they know, identify with and value. Awareness and promotion of the nature and value of ecosystem services need to be enhanced among the general public and especially in school curricula. Promotion of ecosystem services with intrinsic values will be critical when large-scale developments are considered.

**Climate change impacts:** Studies need to be undertaken of the potential environmental, economic and social impacts of climate change on ecosystems and aquatic organisms. Comprehensive risk assessments should also be designed and implemented to prioritize adaptive responses.

## References

- Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D. & Yan, J. 2009. The impact of sea level rise on developing countries: a comparative analysis. *Climate Change* 93: 379-388.

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# Part V

## Assessment of Food Security from Marine Resources

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