Marine Ecosystems: Challenges and Opportunities (MECOS09)

Marine ecosystems provide a number of goods and services to humans. Increased exploitation such as overfishing, coastal development, pollution and urbanization have caused immense damage and pose serious threats to marine ecosystems. Human activities, directly and indirectly, are now the primary cause of changes to marine ecosystems. Natural perturbations have always occurred in the oceans (such as storms, tsunamis), but the resulting changes are mostly reversible. However, effects of many human activities are often irreversible, at least over the span of a human life. Analyzing anthropogenic effects on 20 marine ecosystems using 17 types of human impacts, a team of marine scientists reported in *Science* in 2008 that there is no part of the ocean that is free from at least one type of human impact; and 41% of the ocean is affected by multiple factors. They concluded that two of the biggest threats to marine ecosystems are climate change and overfishing. Human activities have led to global extinction of several marine species although little is known about the exact number. Many species have been hunted to commercial and ecological extinction. More than 25% of fish stocks in the world oceans are stated to be overexploited and another 50% fully exploited.

To address these issues and recommend strategies to convert the challenges into opportunities an international symposium was organized by the 50-year-old Marine Biological Association of India (MBAI) at Cochin during February 9-12, 2009. The symposium was attended by scientists, researchers and teachers from India and abroad. A total of 231 abstracts were accepted for oral and poster presentations in five sessions, viz., ecosystem services, management strategies, ecosystem assessment, opportunities, ecosystem health and a special session on climate change. In all, 755 authors, including three invited keynote speakers contributed and the presenting authors were from 60 affiliations such as research institutions, universities, colleges and NGOs. The Book of Abstracts containing all the abstracts is available in the MBAI website (www.mbai.org.in/mecos.html).

A perusal of the abstracts indicated the topics prioritized for research in this region. When the first announcement of the Symposium was made, seven sessions were proposed, but abstracts were received for only six sessions. There was no abstract for the session on Economics of Ecosystem Restoration. For the special session on Climate Change, we received only 15 abstracts. These two important areas of research should receive increased attention of institutions and universities in the future. Abstracts on several marine plant and animal groups including dinoflagellates, yeast, bacteria, fungi, corals, mangroves, seagrass, finfish, shellfish and cetaceans were received and were presented. Abstracts on sea snakes and sea birds were conspicuously absent. In general, abstracts on linkages between organism-climatic/ oceanographic factors and populations-ecosystems were, to a large extent, missing.

Climate change

In his keynote address on the impact of climate change on marine ecosystems, Keith Brander (Denmark Technological University, Copenhagen) highlighted that the effects of climate change can be detected at individual, population and ecosystem level. Most of the studies of long-term changes and climate impact to date have come from temperate parts of the Atlantic and Pacific and there is a great need for matching information from tropical areas, particularly in the Indian Ocean. The effects of fishing and of climate interact, because fishing reduces the age, size and geographic diversity of populations and the biodiversity of marine ecosystems, making both more sensitive to additional stresses, such as climate change. The frequency and intensity of extreme climate events is likely to have a major impact on future fisheries production in both inland and marine systems. Reducing fishing mortality in the majority of fisheries, which are currently fully exploited or overexploited, is the principal feasible means of reducing the impacts of climate change, he said.

S. Prasanna Kumar (National Institute of Oceanography, Goa) showed that the impact of global warming on the Arabian Sea is the disruption of the

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natural decadal cycle in the sea surface temperature (SST) after 1995, followed by a secular increase in temperature. Concurrent with these events, there are progressively warmer winters, decreased monsoon rainfall, both occurring over India and an increase in the phytoplankton biomass in the Arabian Sea during fall and winter, all of which are linked. He attributed the synchronous increase in the phytoplankton biomass to iron-fertilization during fall and winter by enhanced dust-delivery from the surrounding landmass under increased aridity. Further, the increased phytoplankton biomass is tightly coupled to the higher fish (oil sardine) catch in the eastern and western Arabian Sea after 1995. These results have implication to the food and water security of the region.

According to E. Vivekanandan (Central Marine Fisheries Research Institute, Cochin), the potential outcome of climate change for fisheries may be decrease in production and value of coastal and inland fisheries, and decline in the economic returns from fishing operations. The potential outcome for aquaculture may be higher capital, operating and insurance costs, loss of fish stocks, damage to facilities, conflicts with other water users, reduced production capacity and increased per unit production costs.

In his presentation, J. Sundaresan (National Institute of Science Communication and Information Resources, New Delhi) suggested that the impact of climate change is to be classified into potential near-term impacts and that of far reaching ones. The baseline for risk-based adaptation due to climate change is to be facilitated region-wise depending on the resilience of the regional ecosystem and community. The climate change is to be incorporated to all the future planning. The integrity, effectiveness and longevity of a project are to be ascertained with the climate change. The adaptation is to be evaluated for cost-effectiveness, extreme events and longevity. An adaptation guidance manual may be formulated based on the regional ecosystem and stakeholders, he said.

Marine ecosystem assessment

V. N. Sanjeevan (Centre for Marine Living Resources and Ecology, Cochin) and his team have identified two distinct marine ecosystems in the Arabian Sea along the west coast of India. The northern ecosystem is along Gujarat and Maharashtra coasts and the southern ecosystem is along Goa, Karnataka and Kerala coasts. The physical forcing mechanisms, energy transfer systems and the biological communities are remarkably different between these ecosystems. On the whole, the surface of the southern ecosystem is very productive whereas in the northern ecosystem, the bottom is very productive. The types and quantity of fish abundance, availability and catch is determined by these oceanographic features.

Marine ecosystem health

Commenting on the health of marine ecosystems in India, P.S.B.R. James (former Director, Central Marine Fisheries Research Institute) opined that countries like India, where coastal fisheries are predominant, protection to coastal ocean ecosystems is of paramount importance for the sustainability of fisheries, since coastal habitats account for the highest marine biological productivity. The Coastal Regulatory Zones (CRZs), the Coastal Management Plans (CMPs) and the proposals for the development of industrial corridors along the coastline are not in the interest of protecting marine ecosystems or the marine resources. He suggested that irrespective of any other consideration, all coastal areas, up to the highest high tide mark should be left free from all types of encroachments and activities and reserved for fishing and aquaculture activities.

Management strategies

Intense exploitation of commercial marine species along the Kerala coast has led to threats of species loss, for example, depletion of some species of marine catfish and goatfish. Protection of biodiversity is possible by demarcating marine protected areas (MPA). A study by K.S. Mohamed (Central Marine Fisheries Research Institute, Cochin) and his team has shown that the biodiversity of coast of Thiruvananthapuram district is stressed due to the impacts of fishing. It is possible to reduce the stress by demarcating MPAs. Although the seascape of much of this area is not amenable to trawling due to the rocky and uneven nature of the bottom, the Wadge Bank is located off this area and trawling in Wadge Bank and as far north off Kochi is probably the reason for the stressful condition. Protecting the area from fishing, especially trawling, will be helpful to alleviate stress of the ecosystem, the scientists say. While debate continues on the optimal size and location of MPAs, a growing consensus points towards extensive networks of protected areas of at

least 20% of the habitat as per IUCN guidelines. Therefore, the unique marine ecosystem in Kerala needs to be conserved and steps are necessary to maintain it undisturbed so as to rebuild the stressed habitats.

Opportunities

The discovery of using cadaveric sperm to successfully generate progenies has opened the possibility of adopting a widely practicable method of drawing sperm from freshly dead specimens of fishes preserved at -20^{o}C. In his keynote address on opportunities, T.J. Pandian (Madurai Kamaraj University, Madurai) called for developing this simple technique to fertilize eggs of cultivable fish species such as groupers and to augment the sperm bank facility for a larger number of fish species at relatively cheaper cost.

Several presentations stressed the mariculture prospects for sea plants, bivalves, crustaceans, and edible and ornamental fishes in farms and cages. N.G.K. Pillai and his team (Central Marine Fisheries Research Institute, Cochin) presented the advantageous biological characteristics of the excellent table fish, the cobia *Rachycentron canadum*, which has high growth rate and can be considered for aquaculture. Use of biotechnological tools for resolving biological issues in marine species was the focus of attention of many presenters in this session.

Recommendations

After considering the challenges facing the marine ecosystems, and recognizing that the goods and services provided by marine ecosystems are not adequately utilized, the participants of MECOS 09 developed the following 16 recommendations to mobilize the government and non-government institutions, entrepreneurs and other stakeholders to convert the challenges into opportunities:

1. Considering that the marine ecosystems are served by other ecosystems upland such as the terrestrial, freshwater, estuarine and coastal zone ecosystems and vice versa, a comprehensive policy may be developed by establishing a coordinating organization integrating all the service providing ecosystems and dependent stakeholders.
2. The anthropogenic impacts including fishing, development of coastal corridors, climate change on marine ecosystems and their inter-related marine habitats such as coral reefs, mangroves and sea plants need to be mapped to device conservation measures.
3. As the oceans have no boundary, and are bordered by several countries, it is important to establish collaborations with international organizations and programmes such as Ramsar Convention to safeguard and derive maximum sustainable services from the marine ecosystems.
4. The nodal Ministry may establish a network of Marine Protected Areas (MPAs) in consultation with research institutions and other organizations with due consideration to livelihood concerns and alternatives. The impacts of MPAs on restoration of biodiversity and stock recovery need to be assessed.
5. Considering the absence of estimates on ecosystem costs and values, and the need to revise the species in the IUCN Red List, a detailed assessment in consultation with marine research institutions is urgently required.
6. Taking into account the paucity of information on the endangered fauna and flora, it is important to strengthen research on cetaceans, sirenian, sea birds, marine reptiles, corals, echinoderms, gastropods, sponges and mangrove vegetation; and marine research institutions may be encouraged to develop a cadre of researchers with diving skills.
7. Technology development for extracting beneficial drugs and chemicals from marine species and sea may be strengthened with due consideration to biodiversity concerns.
8. Fisheries prediction models need to be standardized and optimized for addressing specific characteristics and issues in different tropical oceanic realms. Ecosystem-based Fisheries Management may be adopted, to ensure long-term sustainability of fish stocks.
9. Code of Conduct for Responsible Fisheries may be implemented in full scale and National Plans of Action on Excess capacity; Illegal, Unregulated and Unreported (IUU) fishing, Bycatch Reduction and Energy Conservation in fisheries may be adopted and implemented.
10. Taking into account the services provided by the deep sea organisms on oceanic and deep sea ecosystems, research on these organisms should be strengthened for optimal utilization of resources.

11. Considering that the marine ecosystems are affected by long-term climatic changes, continuous monitoring of the impact on the physical, chemical and biological processes is necessary. Options for adaptation to climate change and mitigation have to be developed on a priority basis with international collaboration, and by establishing strategic disaster management systems.
12. Basic research on taxonomy and biology of candidate species for mariculture may be further promoted by colleges and universities.
13. Recognizing the potential of mariculture to supplement and increase food production, and for ornamental trade, new programmes on mariculture with additional emphasis on stock recovery and replenishment may be initiated. To achieve this, hatchery and growout technologies for several candidate species need to be developed with proper policy support.
14. State-of-the-Art technologies such as remote sensing, DNA barcoding and metagenomic approach may be adopted for assessing the marine biodiversity and ecosystems. Palk Bay may be considered for developing facilities for Controlled Experimental Ecosystem Studies.
15. Benign educational tourism may be promoted by establishing oceanaria, marine parks and marine mammal and sea turtle watch etc.
16. The concerned Ministries and Departments should create posts of trained Aquatic Resource Conservators for fulfilling the conservation objectives in respect of the marine ecosystems similar to those of forest ecosystems.

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