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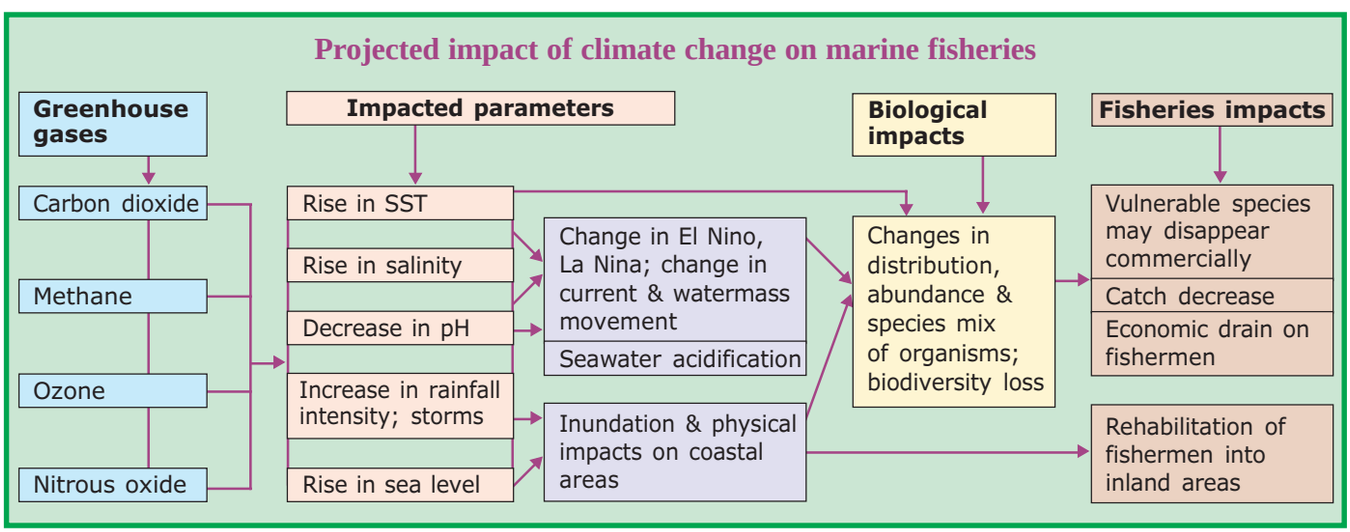
IMPACT OF CLIMATE CHANGE ON MARINE FISHERIES

Climate change is projected to cause massive changes in the environment which are on a scale unprecedented in the last 1,000 years. The causative factors of climate change are the greenhouse gases, *viz*., carbon dioxide, methane, ozone and nitrous oxide. The most confident projections on the fall-out of climate change are for the amount of warming and changes in precipitation. The 20th century is the warmest century in 1,000 years, the 1990s the warmest decade, and 1998 and 2004 the warmest years. The relatively steady warming in the 20th century increased the mean temperature by 0.6° C. However, the projections from global warming models indicate that we may see nearly continuous warming of about 0.5° C per decade for every decade of this century. Thus each coming decade may successively add nearly as much warming as the entire 20th century.

but less mobile and sedentary species may not. Depending on the species, the area it occupies may expand, shrink or be relocated with changes in oceanic conditions. Such distributional changes would result in varying and novel mixes of organisms in a region, leaving species to adjust to new predators, prey, competitors and parasites.

Considering the enormity of the problem and the need to address the issues connected with climate change and marine fisheries including sea food security and livelihood, the CMFRI has taken up a major ICAR Network Project entitled "Vulnerability of Indian Marine Fisheries to Climate Change". In this project, time series data on sea surface temperature (SST) are being gathered and correlated with distribution and catches (as a surrogate of abundance) of marine finfish and shellfish. Trends in SST during



For the marine environment, the projections are the rise in seawater temperature, salinity and sea level, drop in sea surface pH, and changes in the current, upwelling, watermass movement, El Nino and La Nina events. The Intergovernmental Panel on Climate Change has warned that climate change would affect the distribution and abundance of fish species. Many fish species, for instance, have a narrow range of optimum temperatures related both to the species' basic metabolism and the availability of food organisms that have their own optimum temperature ranges. The temperature sensitiveness is just a few degrees higher than those they usually experience in nature. A rise in temperature as small as 1°C could have important and rapid effects on the mortality of some organisms and on their geographic distributions. The more mobile species should be able to adjust their ranges over time,

1961-2005 collected from Comprehensive Ocean-Atmospheric Data Set (COADS) have revealed that the annual average smoothed SST has increased from 27.5°C to 27.75°C (0.05°C per decade) along the northwest coast; from 28.35°C to 28.55°C (0.04°C per decade) along the southwest coast; from 28.30°C to 28.75°C (0.10°C per decade) along the southeast coast; and from 27.90°C to 28.20°C (0.06°C per decade) along the northeast coast of India.

The relationship between changing climatic factors and fish abundance is complicated and the diagnosis of the impact of climate change on fisheries is challenging. One of the problems in assessing the impact of climate change on fish abundance/ catch is the complexity of segregating the climate-induced

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(Impact of Climate ..... Contd. from page 1)

changes in fish populations from other human–induced changes such as fishing. Technological advancements in fishing have substantially influenced the catch and abundance thereby masking the climate-induced changes. The records on catches are influenced by economic factors such as the relative price paid for different types of fish. These non-climatic factors often obscure climate related trends in fish abundance/catch. However, water temperature can be used as a basis for forecasting the distribution and abundance of many species. Water temperature also can have a direct effect on spawning and survival of larvae and juveniles as well as on food availability and fish growth. Most studies on climate change and marine fisheries are on inter-year time scales, such as El Nino and La Nina cycles and Southern Oscillation Index.

Preliminary analysis indicates that the distribution of fish species with more rapid turnover of generations may show the most rapid demographic responses to temperature changes. The distribution of the oil sardine *Sardinella longiceps*, for instance, has responded markedly to increase in sea temperature. With the northern latitudes becoming warmer, the oil sardine, which is essentially a tropical species, is able to establish itself in the new territories and contribute to the fisheries along the northwest and northeast coasts of India.

The strategies adopted by other fish groups are also becoming evident. Some pelagic species such as the Indian mackerel *Rastrelliger kanagurta* show shift in the depth of distribution and are now caught by bottom trawlers. Demersal species such as threadfin bream *Nemipterus japonicus* appear to shift the month of peak spawning toward colder months off Chennai. There are also indications, which show that copepod abundance is shifting toward colder months off Mangalore. These findings indicate that the adaptable species may be able to adjust to the immediate challenge of rise in temperature for a shorter or longer duration. On the other hand, the vulnerable groups such as the corals are in peril. It is found that extensive coral bleaching occurred in Gulf of Mannar and Andaman and Lakshadweep Seas when the SST was 31^{o}C or more in 1998 and 2002. The intensity of bleaching was directly related to the number of days the higher temperature prevailed.

These initial results emphasize the need for finding answers to several questions. What will be the influence of rising seawater temperature on the bombay duck, whose northern boundary is landlocked? The distribution and migration of oceanic tunas, which are influenced by thermocline, may be strongly influenced. The sex of sea turtles is critically determined by the soil temperature at which the embryo develops. Temperature above 28^{o} C produces only females. How the turtles would adopt to this crisis? Will there be species succession of phytoplankton with the domination of temperature tolerant species? Is the massive intrusion of pufferfish and medusae into the Indian coastal waters in recent years a fall out of climate change?

It is much more difficult to project how populations will behave under radically different conditions. Under these conditions, fisheries stock assessment, already difficult, may prove impossible. Fisheries management will likely become far more contentious because the abundance of fish populations and the composition of communities will change in unexpected ways.

The effects of climate change on fisheries will affect the fisheries sector that is already characterized by stagnating catches, full utilization of resources, large overcapacity and conflicts among fishers. The existing craft and gear combinations may have to be modified due to changes in resource composition. Due to sea level rise and inundation, the coastal fishing communities will be the worst affected. The mean sea level (MSL) has increased at the rate of 0.705 mm, 1.086 mm and 3.772 mm per year in the Arabian Sea, Bay of Bengal and Andaman Sea, respectively during 1992-2005.

Projections on future scenarios of the impacts, building awareness, preparedness, and planning and implementing the mitigation measures should start now so that the insidious changes are anticipated and addressed.

(Prepared by Dr. E. Vivekanandan, Head, Demersal Fisheries Division)

RESEARCH HIGHLIGHTS

Mussel seed settlement along Malabar coast

The green mussel *Perna viridis* Linnaeus 1758 forms a significant fishery along the Malabar coast. The species forms extensive beds on the laterite and granite formations along Kasargod to Calicut in the intertidal and subtidal zones up to 15-20 m depth. Mussel pickers collect the adult mussels from these beds by diving and separating them off the rocks. Spat settlement occurs on laterite formations along South beach, Chaliyam, Elathur, Kollam, Moodadi and Thikodi and on granite rocks in Chombala, Mahe, Thalassery, Thalai, Koduvally, Kadalai, Chembarika, Kottikulam and Bekel.

Seed extracted along with adult mussels : Thikkodi

Settled mussel seed : Thikkodi

Mussel seed settlement pattern and abundance along the Malabar coast was surveyed during November 2006. Spat settlement commenced from August onwards. The settlement was poor compared to the very dense settlement observed during the previous year. The rain fall pattern has affected the settlement pattern. The mean annual rainfall in Kozhikode and Kannur was 377 mm with average monthly rainfall of 13.6 mm. Continuous sustained rainfall over a longer period from August through December has drastically affected the spat settlement along the coast. This has created serious concern to the mussel farmers in the Malabar region.

Retarded mussels being used for bottom culture : Thikkodi

The total mussel seed biomass along Kozhikode, Mahe and Kannur was estimated at 4,541 t; The mean mussel biomass in an estimated total mussel bed area of 436 ha was 10 kg m^{-2}. Chaliyam recorded the highest average biomass per m^2 at 1.6 kg m^{-2} (15.8 %) followed by