CMFRI

Winter School on
Impact of Climate Change on Indian Marine Fisheries

Lecture Notes

Part 1

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CHALLENGES POSED BY CLIMATE CHANGE IN THE FUTURE SCENARIO OF COASTAL AQUACULTURE

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Introduction

Aquaculture is considered as a sunrise sector for increasing fish production since the capture fisheries have reached almost stagnation levels. With more than 8% annual growth globally, the sector is now considered as the fastest growing food producing sector in the world. Today aquaculture provides around half of the fish for human consumption and this share will need to grow further. The global aquaculture production showed that 25.8 million tonnes (m t) of freshwater organisms were produced (43.8%), 30.2 m t (50.9%) of marine organisms, and 3.4 m t of brackishwater organisms comprising nearly 63% shrimps (FAO, 2006).

Mariculture is the farming and husbandry of marine plants and animals in marine environments. Although we have vast cultivable coastal areas, the annual production is only about 80,000 to 1,00,000 tonnes, and that too is from brackishwater shrimp aquaculture. A trade of marine ornamental fishes and other tropical marines is emerging in recent years. The techno-economic and commercial viability of mariculture in Indian conditions is yet to be demonstrated and practiced except for shrimp and a few bivalves. The potentially cultivable candidate species in India include about 20 species of finfishes, 29 crustaceans, 17 molluscs, 7 seaweeds and many other species of ornamental and therapeutic values. Many mariculture technologies are very simple, eco-friendly and use locally available infrastructure facilities for construction of farm, feed and seed, and hence the fishermen can practice the entire farming. Another advantage is that most of our brackishwater and coastal areas are free from pollution and suited for aquaculture. But hardly 10% of the potential cultivable area is presently used for aquaculture in spite of growing demand for cultured shrimp, bivalves, crabs, and lobsters etc., all of which are in high demand in the export market.

Threat of Climate Change

It is now widely accepted that fisheries and aquaculture are threatened by climate changes, and hence, it is necessary to understand the nature of threat for developing strategies for coping up with the same. Temperature is predicted to increase more at higher latitudes compared with equatorial areas. As a global average, precipitation levels are predicted to increase. Changes in seasonal variation will also be important and may lengthen or shorten growing seasons of farmed organisms in relation to water availability or increase the risk of flood damage at certain times of the year. Mean sea level is predicted to increase between 10 and 90 cm during the 21st century with most predictions falling within the 30 to 50 cm range although some uncertainty remains in relation to land-based ice in Antarctica and Greenland. Changes in climate variability and extreme events are considered harder to predict although increases in the intensity of precipitation events, risk of drought and peak cyclone wind intensities are considered likely in some areas. Changes in ocean currents may have a substantial influence on the world's climate which will in turn have significant direct effects on mariculture through changes in temperature, primary productivity and hence food availability, and the distribution of disease, toxic algae blooms and predators (WorldFish Center, 2006).

Impacts of Climate Change

(i) Sea surface temperature changes: The following impacts can be anticipated on culture systems

- Increase in harmful algal blooms that release toxins in the water and produce mass mortality of fish

- Decrease in dissolved oxygen
- Increased incidence of disease and parasites
- Enhanced growing seasons
- Change in the location and/or size of the suitable range for a given species
- Lower natural winter mortality
- Enhanced growth rates and feed conversions
- Enhanced primary productivity to benefit production of filter feeders
- Altered local ecosystems – competitors and predators
- Competition, parasitism and predation from exotic and invasive species
- Damage to coral reefs that may have helped to protect shore from wave action – may combine with sea level rise to further increase exposure

The following operational impacts are expected:

- Changes in infrastructure and operational costs
- Increased infestation of fouling organisms, pests, nuisance species and/or predators
- Expanded geographic distribution and range of aquatic species for culture
- Changes in production levels
- Increased chance of damage to infrastructure from waves or flooding of inland coastal areas due to storm surges

(ii) Change in other oceanographic variables (variations in wind velocity, currents and wave action)

The following impacts are anticipated:

- Decreased flushing rate that can affect food availability to shellfish
- Alternations in water exchanges and waste dispersal
- Change in abundance and/or range of capture fishery species used in the production of fish meal and fish oil

The major expected operational impacts are:

- Accumulation of waste under pens
- Increased operational costs

(iii) Sea level rise: The impacts anticipated on culture systems include

- More areas may be available for coastal aquaculture
- Loss of areas such as mangroves that may provide protection from waves/surges and act as nursery areas that supply aquaculture seed
- Sea level rise combined with storm surges may create more severe flooding
- Salt intrusion into ground water

The expected operational impacts include

- Damages to infrastructure
- Changes in aquaculture zoning

- Competitions for space in ecosystems like mangroves
- Reduced freshwater availability

*(iv) Increase in frequency and/or intensity of storms***:** The anticipated impacts on the culture systems include

- Larger waves
- Storm surges
- Flooding from intense precipitation
- Structural damage
- Salinity changes
- Introduction of disease or predators during flood episodes

The expected operational impacts include

- Loss of stock
- Damage to facilities
- Higher capital costs, need to design cages moorings, jetties etc that can withstand events
- Negative effect on pond walls and defenses

*(iv) Floods due to changes in precipitation***:** The anticipated impacts on culture systems include

- Salinity changes
- Introduction of disease or predators
- Structural damage
- Escape of stock

The expected operational impacts include

- Loss of stock
- Damage to facilities
- Higher capital costs involved in engineering flood resistance

(v) Drought (as an extreme event): The anticipated impacts on culture systems include

- Salinity changes
- Reduced water quality
- Limited water volume

The expected operational impacts include

- Loss of stock
- Loss of opportunity – limited production

Strategies for adapting to the challenges of climate change in coastal aquaculture/mariculture

It is evident that climate change will increase the potential of aquaculture in some regions and reduce in others. Aquaculture is an important means of diversifying and improving the productivity of farming systems and for improving food security in many regions especially in Africa and Asia. Implemented properly, it can help conserve water and its potential to help farmers adapt to climate change is enormous. The following strategies appear to be relevant:

- Because of their short generation time and large multiplication rate, fish can be quickly and efficiently selectively bred to suit to the new conditions that are likely to be brought about by climate change.
- Research on diversification of species and farming practices to suit the impact of climate change is needed.

- Breeding and seed production of fast growing and hardy species of tropical finfish and shellfish have to be taken up.
- Natural fish seed availability from mangroves may be reduced due to loss of mangrove habitats and hence alternate sources for seed for aquaculture have to be resorted.
- Since loss of coastal areas and flooding is anticipated, coastal aquaculture areas have to be selected by taking these aspects into consideration.
- Coastal agricultural lands, which will become unsuitable for crop production because of increased seawater intrusion, can be deployed for coastal aquaculture.
- Offshore mariculture practices such as cage farming have to be designed for withstanding the expected increased intensity/ frequency of storms.

References

FAO 2006**.** State of world aquaculture 2006. FAO, Rome, Italy. 134pp.

World Fish Centre 2006. The Threat to Fisheries and Aquaculture from Climate Change. Policy Brief, www.worldfishcenter.org.