

Climate resilient multi-trophic system in Vembanad lake

Adaptive Strategy for Enhancement of Clam Fisheries

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Vembanad lake was designated as a wetland of international importance under the Ramsar Convention in 2002. The second largest brackishwater lake of Kerala is spread across an area of over 2,033.02 km² and is an essential habitat to a variety of biologically and economically important resident and migratory aquatic fauna as well as avian resources. It is also classified as 'Critically Vulnerable Coastal Area' as per the CRZ Notification, 2011 by the Ministry of Environment, Forest and Climate Change.

Key words: Clam fisheries, Climate resilient multi-trophic system, Vembanad lake

THE geographical location range of the lake extends between 9.512 N and 10.186 N and longitude 76.163 E and 76.429 E. Nearly 117 species belonging to 38 genera, 23 families and 9 orders were recorded from Vembanad lake. The diversity included 2 introduced fishes, viz. *Catla catla* (Katla) and *Labeo rohita*

(Rohu) and 2 exotic fishes, viz. *Pangasianodon hypophthalmus* (the Sutchi catfish) and *Oreochromis mossambicus* (Tilapia). The wetland provide suitable spawning and breeding habitats for several migratory and residential aquatic species. The giant river prawn *Macrobrachium rosenbergii* for whom the Vembanad ecosystem forms a natural abode, is a classic example of the ecological significance of the lake. Major fishery resources of the wetland include *Villorita cyprinoides* and *Etroplus suratensis*.

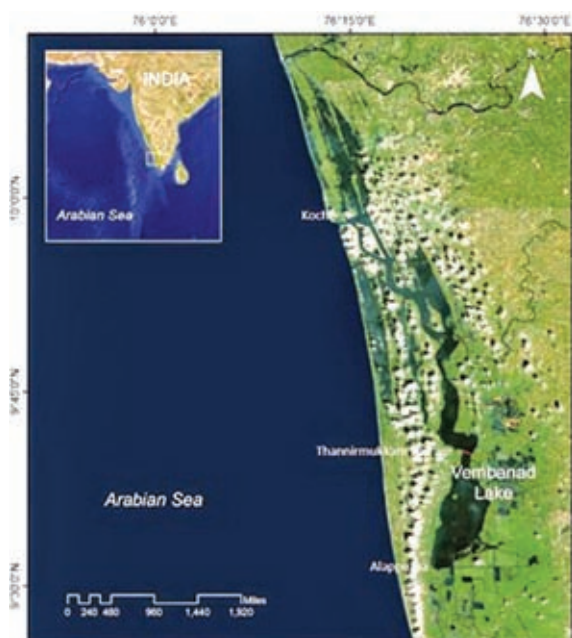
Impact of anthropogenic activities:

A water regulator constructed at Thanneermukkom of nearly 1.25 km built across the lake to control salt water intrusion for safeguarding the agriculture around the lake affected hugely the

opportunity for fishes and shellfishes for anadromous migration, caused rampant propagation of the water hyacinth and restricted the natural flushing of pollutants. Anthropogenic activities in the wetland such as uncontrolled mining of shells from the lake bed, sewage effluents and the heavy load of organic material destroyed the ecosystem. Fisher started to rely upon alternative livelihood options such as agriculture, fishing, tourism, inland navigation and coir retting due to low income from disrupted ecosystem.

Climate change along with frequent sporadic occurrence of extreme events accompanied by greenhouse gas emission due to anthropogenic interventions has been identified as one of the greatest threats to environment conservation and living security.

Climatic variables: The area experiences a tropical humid climate with an average annual rainfall of about 3,300 mm. Of the total rainfall, southwest monsoon (June–September) contributes about 75%





Pen culture at Thycattusserry

and the remaining by northeast monsoon (October–December) and summer showers. Being a tropical country, climate variables taken up for analyses were rainfall and water temperature.

In Kerala, the mean rainfall trend showed a decreasing trend from 1981 to 2016 and the decrease was nearly - 5.96 mm. The rainfall showed a deficit of 20 to 40 mm from 2000 to 2016 in Kerala except in 2007 and 2013. The annual mean temperature of India has increased approximately by 1 degree Celsius as compared to 20th Century. During 1901-2017, the annual mean temperature showed an increasing trend of 0.66°C/100 years with significant increasing trend in the maximum temperature (1.06°C /100 years), and relatively lower increasing trend (0.26°C/100 years) in the minimum temperature.

CIFRI assessed the losses due to climate change to the clam fishers livelihood and income and estimated that fishers has incurred occupational loss to the tune of Usha ₹ 20,000 and

livelihood loss to the tune of nearly ₹ 10,000 due to climate changing scenarios. The average annual catch per hectare of the lake has shown a three times decrease in production from 333.72 kg (1988-1999) to 132.84 kg (2016). This low production has impacted nearly 5,000 clam fishers. The study indicated a need for adaptation strategies to combat such extreme climatic events by devising various income enhancement programmes of clam fishers.

Technology devised: Various enhancement programmes and technologies such as clam relaying and rack culture were devised to increase production of black clams (*Villorita cyprinoides*) *in situ* in Vembanad Lake in the context of decline in clam harvests and low income. Successful demonstration of clam culture in multi-trophic pens was done for the first time by Central Inland Fisheries Research Institute (ICAR-CIFRI) under National Innovations on Climate Resilience in

Agriculture (NICRA) project in this Ramsar site.

***Villorita cyprinoides* at Thycattussery:** Thycattussery area had a clam bed of 28 ha area with estimated production of 296.86 kg/ha as reported during 1988-1989 and has reduced now to 17 kg/ha. So the clam culture was done at Thycattussery area as a part of stock replenishment programme. Further, the trophic status of Thycattussery which was estimated at 48.45 indicated an oligo-mesotrophic condition further suggesting that the production from this ecosystem system may be enhanced using pens or cages by utilizing the multi-trophic levels in the aquatic ecosystem. Salinity, dissolved oxygen and sandy loamy soil substratum were found to be the factors affecting clam production in the lake. Clams were thus chosen for aquaculture system in pens as it is was a sessile filter feeder utilizing bottom niche and it ensured conversion of the atmospheric carbon to blue carbon and thus acting as a



Black clam *Villorita cyprinoides*

carbon sink. Studies indicated that the culture of clam assimilated 10.8 tonnes of carbon/year and the rate of carbon removal was 80 tonnes/hectare/year.

Adaptation strategies:

Considering the uncertainties of the climate change, it is necessary to develop climate resilient strategies that both support general development and climate adaptation in the vulnerable ecosystem. Protection of wetland biodiversity and integrity are important activities to improve the resiliency of wetland ecosystems so that they continue to provide important services under changed climatic conditions. Location specific and innovative adaptation and mitigation strategies would bring community empowerment in the face of climate change.

The climate resilient pen structures (CRPS) at Thycattussery was set up with the co-operation of clam fishers registered under the Thycattussery Black clam Industrial co-operative society, Reg No - A239, Thycattussery, Alappuzha, Kerala. CRPS is made of high tensile strength HDPE net material which helps to withstand flood and wind action. CRPS offers safe and secure environment for resilient indigenous species which are stocked in this system.

Technical specifications: The CRPS at Thycattussery was made of bamboo which is a locally available low cost material. The bamboo was erected at 1m gap to withstand the current and wind action in the system and to disperse the wind borne

floating weeds such as *Eichhornia* sp out of the system. *Eichhornia* sp if not dispersed may sink to the bottom after drying up and would smog the clam fishes to death. Nets walls made of HDPE were used to encircle the bamboo structure to delineate the culture area from the surroundings and also to integrate fishes into the system to utilise the column niche of the system. Pens reduced the fisher's effort in harvesting of clams from wild and helped in targeted harvesting.

The height of the pen wall is decided based on highest depth encountered during peak monsoon. The pen height was kept to the tune of 6 to 8 feet to counter the flooded condition of the wetland during peak monsoon. The pen system were installed at places after studying the site compatibility to the culture of the selected species in the system. The wetland is vulnerable to tidal fluctuations and so the site chosen recorded lowest mean depth of 1 m during peak summer season. The pen

structures of 114 sq m was divided into two compartments prior to stocking in order to monitor the growth rates of the stocked species. The pen was stocked with Black Clam, *Villorita cyprinoides*.

Small and large clams collected from the wild (Paathiramannal) were segregated and stocked at the rate of 5,000 nos/ sq m and 2,000 nos/sq m approximately and an overall 650 kg of baby clams were stocked in the pens where in the culture was taken up for a year. The annual growth rate of clams was assessed in terms of length and weight as 14.23 mm/year and 47.98 g/year. The average production obtained from the pen was 2,000 kg. The culture earned a revenue of ₹ 26,300 from sales of clam meat and clam shell. The meat and the shell was separated, washed and sold at ₹ 100/kg whereas the shell was sold at ₹ 3,500/tonne. Thus, in a very short payback period of one year, benefit cost ratio (BCR) of 1.26 was obtained.

This culture activity assimilated



Black clam *Villorita cyprinoides* harvesting



0.915 tonnes of carbon. The carbon costed ₹ 40/tonne. The co-operative society included nearly 1,200 active clam fishermen.

Advantages

The CRPS has got many advantages in the context of changing climatic scenario as given below;

- Protection from adverse climatic events like flood, heavy wind action etc.
- Suitable for seed raising as well as table fish production
- Resilience to fluctuating water levels in wetlands on account of tides and rainfall
- Better biosecurity compared to normal pen enclosures
- Tapping of natural productivity (food)
- Environmentally viable and cost effective
- Low maintenance cost and high shelf life
- Intensive utilization of space and

ease of harvest

- Greater production is assured in a limited space with rich food and oxygen supply.
- Greater growth is possible as energy is saved towards locomotion and feeding.
- Availability of natural food and exchange of materials with the bottom.
- Easier stock management and monitoring.

Successful clam culture in CRPS in inland waters became possible with the joint efforts of ICAR-CIFRI Kochi centre and the fishers of Thycattussery Black Clam Co-operative society. ICAR-CIFRI provided complete technical support from selection of site to clam harvesting under its supervision and monitoring. This system of fish production would be modified into multi-trophic pen culture structures in the coming years by introducing various fish species in the column

niche. This would be a suitable technology to support better livelihood for the associated fisher communities and female family members in the inland aquatic system where in double income from fishes as well as clams are ensured. The technology not only would provide a better livelihood but also act as a carbon sink which would help in reducing the carbon emissions from wetlands so as to curb global climate change.

SUMMARY

Vembanad Lake was famous for Black clam (*Villorita cyprinoides*) resources which has depleted across the years. Thycattussery area had been selected for clam replenishment activity as the 28 ha clam bed area with estimated production of 296.86 kg/ha as reported during 1988-1989 has reduced now to 17 kg/ha. Further, the trophic status of Thycattussery which was estimated at 48.45 indicated an oligo-mesotrophic condition further supporting production enhancements from the system using pens or cages by utilizing the multi-trophic levels in the aquatic ecosystem. The CRPS not only could with stand climatic vagaries but also acted as a carbon assimilation as well as blue carbon sink system. The system has a BCR of 1.28 indicating feasible production system.



Active fisherwomen in clam harvesting

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