Assessment of biogeochemical processes of Ashtamudi Lake ecosystem in relation to clam fishery

D. Prema, K. S. Mohamed, V. Kripa, B. Jenni, P. S. Alloycious, K. K. Sajikumar, K. S. Aswathi, K. S. Abhilash, P. S. Anilkumar and M. P. Syamala
ICAR-Central Marine Fisheries Research Institute, Kochi

Background

The Ashtamudi Lake ecosystem in Kerala (southwest coast of India) is well known for its clam resources. This estuarine system contributes approximately 80% of the total clam export trade of India besides providing livelihoods for at least 3,000 local people. Among bivalves, clams are an important source of meat for human consumption while its shells are used in the cement industry.

As part of eco-labelling the scientifically managed clam fisheries of Ashtamudi Lake, the ICAR-Central Marine Fisheries Research Institute (CMFRI) in collaboration with World Wide Fund for Nature (WWF) probed the ecosystem benefits coming out of the management initiatives. Under the clam management programme, the stock status of clams of Ashtamudi Lake is assessed every year. Five zones were identified (Mohamed *et al.*, 2013.

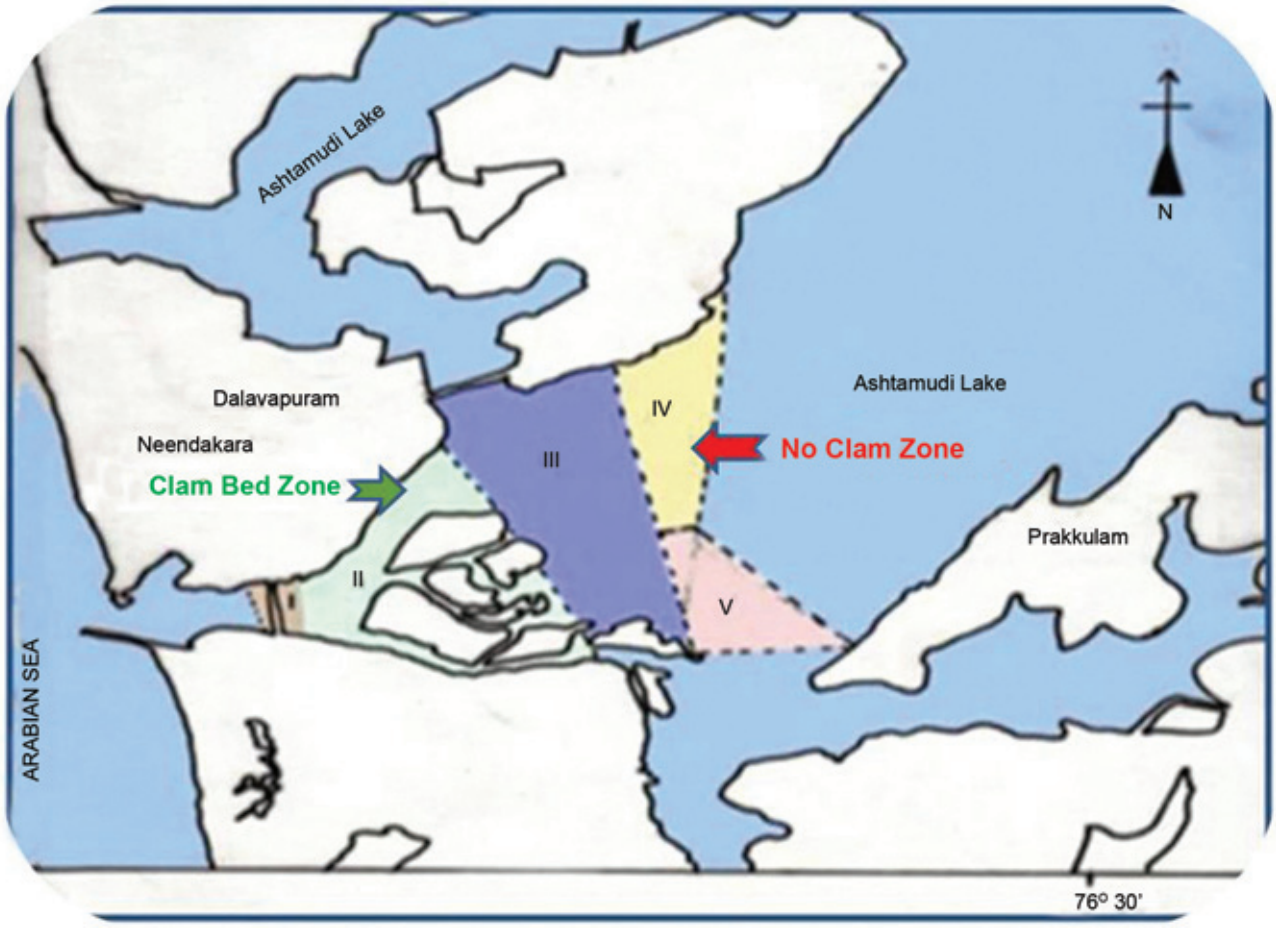

Fig . 1. Map of Ashtamudi Lake showing sampling zones

CMFRI Special Publication 114) of which Zone II and Zone IV were selected for the present study. Accordingly, a rapid appraisal of selected biogeochemical processes was carried out in these two zones analyzing two scenarios in Ashtamudi Lake (a) Clam bed with fishery in Zone II and (b) No clam in Zone IV respectively (Fig 1).

Methodology

The physico-chemical parameters were analysed by sampling water and sediment from these zones. The clam bed with fishery in Zone II (Scenario A) and No-clam bed (Scenario B) were compared for understanding the differences in bio-geochemical processes occurring in these two types of habitats. Samples of water, sediment, plankton and benthos were examined using standard methods. Assessment of water quality (in terms of nutrients, particulate organic matter, particulate inorganic matter, chlorophyll, Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD) etc.) and sediment quality in terms of organic carbon, oxidation reduction potential, available nutrients, texture etc. were done using standard procedures.

Results

The clam bed with fishery had marked variation in the selected biological characteristics from No-clam zone (Table 1). The observed water quality parameters are given in Table 2. The water quality remains within the optimum range in the presence of clams with fishery. The sediment quality assessment for the two scenarios is given in Table 3. The sediment quality was found to be better in the presence of clams. The role of clams in maintaining a healthy ecosystem was evaluated. These results are presented in Table 4 with probable reason for each observed effect.

Table 1. Biological characteristics of selected locations in Ashtamudi Lake

Biological Characters	Zone II Clam Bed with Fishery	Zone IV No Clam Zone
Mean Clam (Numbers)	85	0
Mean Clam weight (g)	196	0
Diatoms Count (millions ml^{-1})	3.507	3.107
Benthos Biomass, (g m^{-2})	48.44	95.16

The comparison of ecosystem processes made in the two scenarios, based on the results of water

Table 2. Water quality characteristics at selected locations

Parameters	Zone II Clam Bed	Zone IV No Clam	Optimum range
Chlorophyll a, µg l^{-1}	21.34	18.93	17-40
Temperature, ^{O}C	27.5	28.4	25-32
Salinity, PSU	30	28	2 - 48
Dissolved oxygen, mg l^{-1}	4.44	4.44	5 -10
TSS, mg l^{-1}	154.1	78.1	25-200
BOD, mg l^{-1}	0.49	0.89	<15
COD, mg l^{-1}	19	10	<70
Particulate Organic matter, mg l^{-1}	23.59	16.17	
Particulate Inorganic Matter, mg l^{-1}	130.5	61.92	
pH	7.5	7.6	7.0-8.7
Total ammonia – N, mg l^{-1}	0.094	0.03	0-0.1
Nitrite – N, mg l^{-1}	0.003	0.003	0-0.5
Nitrate – N, mg l^{-1}	0.051	0.05	0.1-3
Dissolved orthophosphate, mg l^{-1}	0.003	0.001	<0.01
Silicate, mg l^{-1}	1.68	0.303	> 5

Table 3. Selected Sediment Quality characteristics of Ashtamudi Lake

Parameters	Zone II Clam Bed	Zone IV No Clam	Optimum range
Sediment organic carbon, %	1.77	0.9	1.5 – 2.5
Oxidation – Reduction Potential, mV	-44	-97	> -200
Salinity, PSU	11.49	7.15	> 2.2
Ammoniacal – N, ppm	3.23	1.85	Together as available nitrogen, 250 - 750 ppm
Nitrite- N, ppm	0.05	0.02	
Nitrate-N, ppm	0.36	0.33	
Available Phosphorus, ppm	77.35	60.29	> 60
pH	7.22	7.65	6.5 – 7.5
Sand, %	68.6	82.1	40
Silt, %	17.0	10.9	30
Clay, %	14.1	6.8	30

Table 4. Comparative analysis of Scenario A: Clam bed with fishery versus No Clam Zone

Parameters	Scenario A : Clam Bed with fishery	Probable reason
Diatoms	Diatoms more	More nutrient release
Chlorophyll	≈1.13 times more	More nutrient release
Water temperature	≈ Same	
TSS	≈ 2 times more	May be due to clam fishing
Water salinity	≈ Same	
DO	≈ Same	
COD	≈ 1.9 times more	More oxidation due to clam bioturbation
Water pH	≈ Same	
Total ammonia-N in water	≈ 3 times more	From clam faeces
Nitrite-N in water	≈ Same	
Nitrate-N in water	≈ Same	
Dissolved orthophosphate in water	≈ 3 times more	From clam faeces
Silicate in water	≈ 5.6 times more	From clam faeces
Particulate organic matter	≈ 1.5 times more	From clam faeces
Particulate inorganic matter	≈ 2 times more	From clam faeces
Sediment organic carbon	≈ 2 times more	From clam faeces
Sediment salinity	≈ 1.6 times more	More nutrient release
Ammoniacal N in sediment	≈ 1.8 times more	From clam faeces
Nitrite N in sediment	≈ 2.5 times more	From clam faeces
Nitrate in sediment	≈ 1.09 times more	More oxidation due to clam bioturbation
Oxidation –Reduction Potential in sediment	≈ 2.2 times more oxidative	More oxidation due to clam bioturbation
Available phosphorus in sediment	≈ 1.3 times more	More oxidation due to clam bioturbation
Sediment pH	≈ Same	
Sand in sediment	≈ 1.2 times less	From clam faeces
Silt in sediment	≈ 2 times more	From clam faeces
Clay in sediment	≈ 1.6 times more	From clam faeces

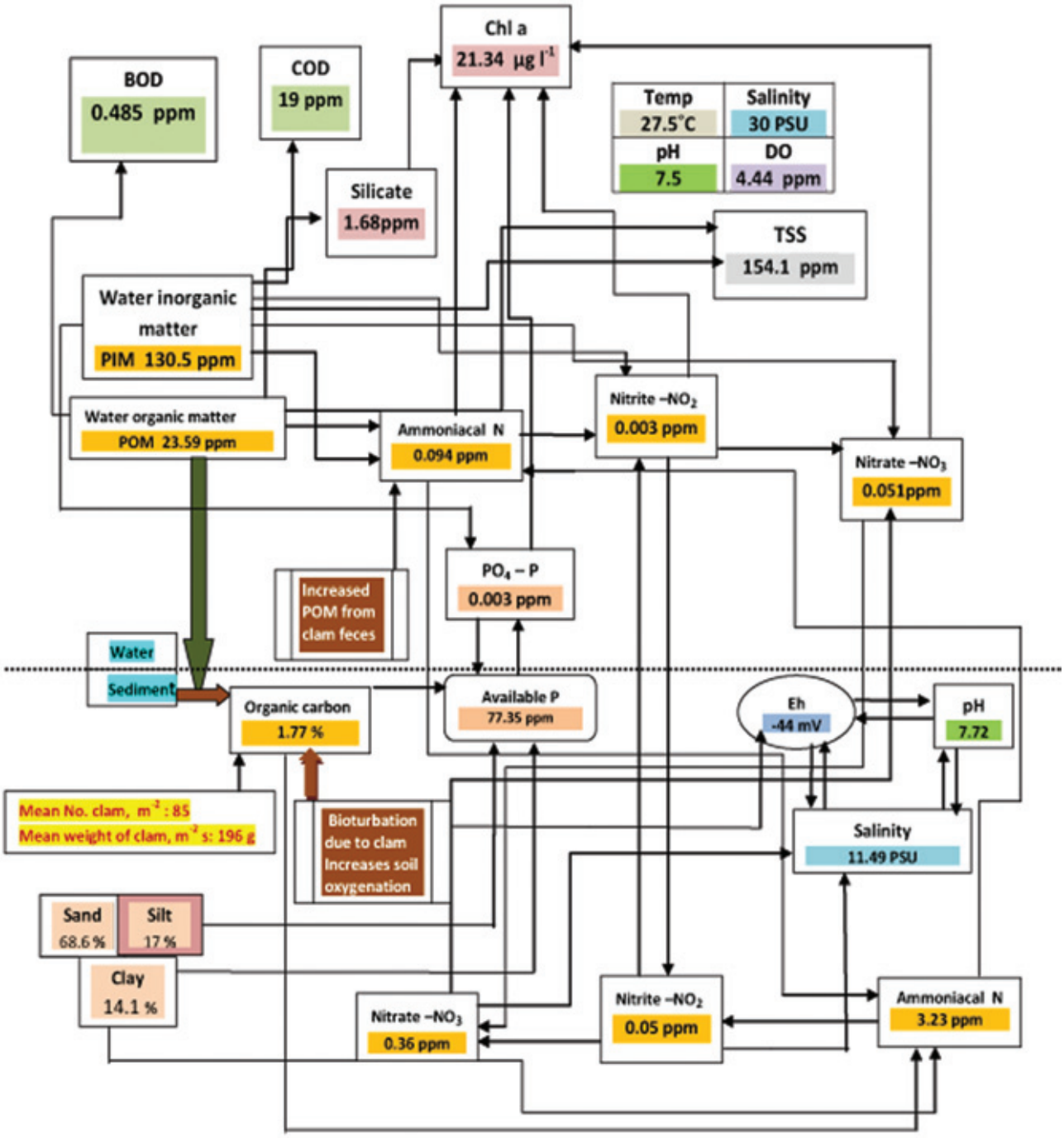

Fig. 2. Ecosystem processes in Ashtamudi Lake in clam bed with fishery (Scenario A)

and sediment quality revealed the following biogeochemical cycles as depicted in Figs. 2 and 3.

- In the Ashtamudi Lake clam bed with fishery, oxidation reduction potential of surface sediment was two times higher due to bioturbation by clams and the amount of nutrients released in the water was three fold higher, compared to the No-Clam Zone.

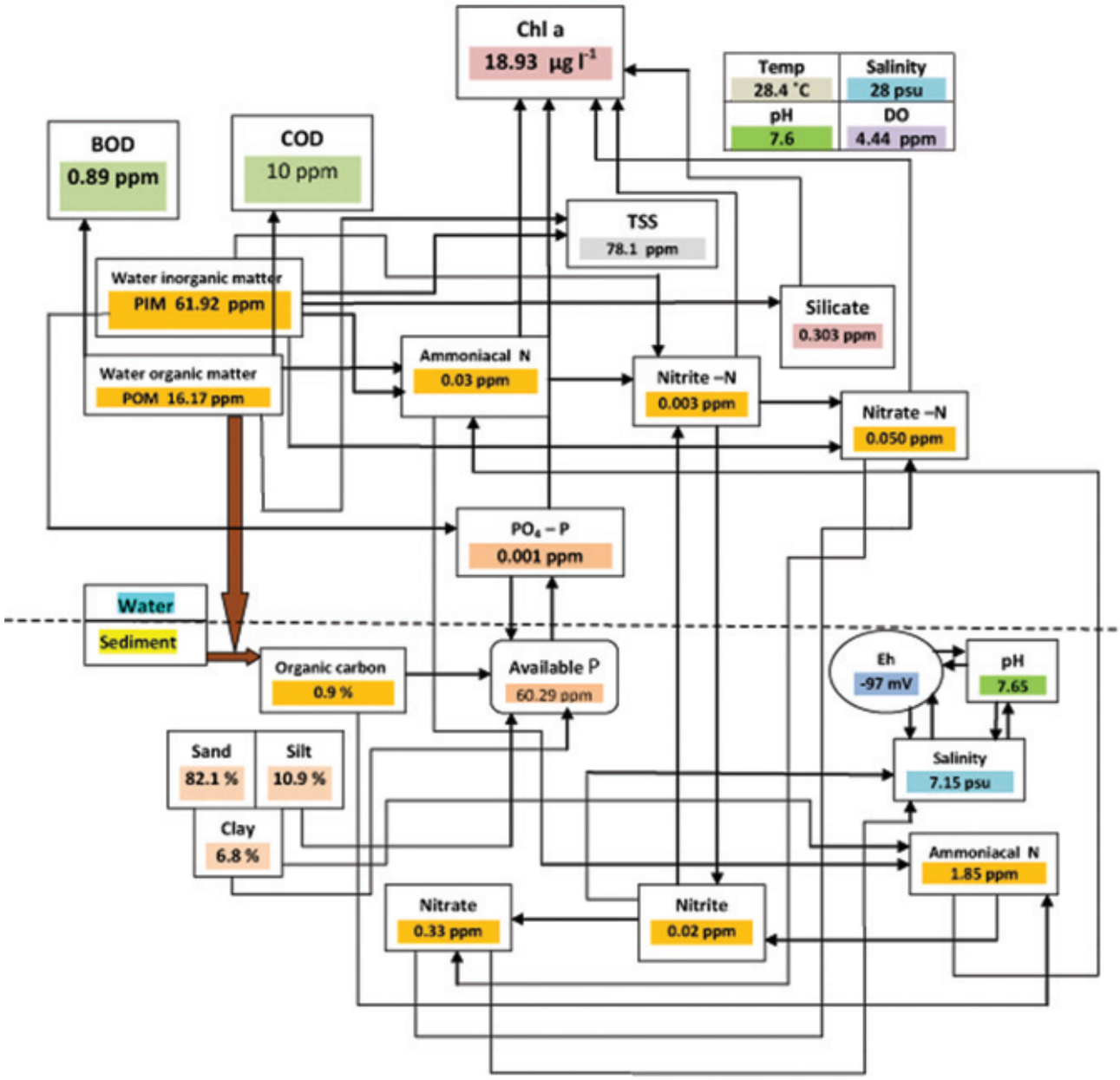

Fig. 3. Ecosystem processes in Ashtamudi Lake in No-clam region (Scenario B)

- Beneficial effects on biogeochemical processes were indicated in areas where clam resources are fished.
- The environmental quality indicators remained well within permissible levels (as per UNEP standards) in clam bed with fishery, improving the ecosystem processes simultaneously.
- Sustainable maintenance of clam beds with optimum fishery is necessary for the general ecological health of the Ashtamudi Lake

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