A STUDY ON CULTURAL EUTROPHICATION IN LENTIC ECOSYSTEM OF DHUKESHWARI TEMPLE POND DEORI DIST. GONDIA

SUMMARY OF FINAL REPORT

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Summary:

1. Eutrophication is a natural process of changes in physical, chemical and biological characteristics concerned with nutrients, organic matter and silt enrichment, known as aging. In healthy pond both nutrients occur in limiting amounts, restricting plant growth, however anthropogenic activities or factors can dramatically increase the concentration of plants nutrient in water bodies, a phenomenon known as Cultural Eutrophication (Hasler 1947). Human-induced pollution through the impacts of excessive fertilizer use, untreated wastewater effluents, and detergents significantly increases nutrient loading into lakes, accelerating eutrophication beyond natural levels and generating deleterious changes to the natural ecosystem (Litke 1999). The term Eutrophication is used to describe the biological effects of increased concentration of plant nutrients usually nitrogen and phosphorus in the aquatic ecosystems. The eutrophication entails deterioration of water quality as well as in water treatment when it is used for water supplies for domestic, agricultural or industrial purpose. It may impair the aesthetic and hygienic qualities of the reservoirs. The main sources which add excess of nutrients in ponds, lakes and reservoirs are sewage from urban areas, fertilizers from agricultural fields, detergents from cloth washing etc. through microbial

decomposition of sewage, BOD of water increases due to oxygen depletion and it is associated with release of nutrients in the water body, in this sequence eutrophication ultimately results in, appearance of undesirable algae weeds due to increased biological productivity, decline of fish and other organism populations, alter macrophyte vegetation and reduced diversity. Several studies have been undertaken to determine the effects of eutrophic waters on aquatic flora and fauna as well as on oxygen concentration. The biological community such as zooplankton, Phytoplankton, benthos and macrophytes, is affected by eutrophic water and results in both short term and long term changes in structural and functional attributes.

2. We have large number of lentic ecosystems and most of them are approaching fast to an undesirable state. Therefore from the point of view of the sustainable development, therefore a complete limnological knowledge of lentic ecosystem is essential for safe guarding the valuable resources.

3. Reports on the limnological profiles of lentic ecosystems are available from the country and other parts of the states but there is no report on the aspect of Cultural Eutrophication in lentic ecosystem in one of the Tribal district like Gondia of Maharashtra, therefore this investigation was undertaken.

4. In the present Investigation, the freshwater lentic ecosystem of Dhukeshwari Temple pond was investigated for the cultural eutrophication for two years from 2014 to 2016. Temple pond was about 50 years old nearby Goddesses "Dhukeshwari" Temple (N 21^0 4' 29.4405", E 80^0 21' 44.6565") along the National Highway Number Six. Increase in anthropogenic activities, culminating in the introduction of untreated domestic sewage and immersion of idols and other socio-cultural practices also contributed to nutrient enrichment of this pond.

5. The main objective of the physicochemical analysis of water is to determine its nutrient status. The samples for physicochemical and biological characteristics were collected monthly from the sampling site. Monthly and seasonal variations were recorded.

6. The surface water sample is collected monthly from the month of September and analyzed in the laboratory. The surface water temperature was recorded in the field itself during the collection of water samples using a sensitive thermometer (1/10°C) and expressed in Degree Celsius (°C). pH of sample was determined by using the Digital portable water analysis kit. The transparency of water column was measured by using a Secchi Disc to determine the photic zone. TDS determined as per the APHA, 1975). The D.O. was determined by adopting the modified Winkler's method. The free CO_2 was determined by adopting the titrimetric method with the help of phenolphthalein indicator solution. The total alkalinity of the water sample was estimated by titration method (APHA, 1975), using phenolphthalein and methyl orange as an indicator. The total Hardness of water sample was determined by EDTA Titrimetric method (APHA, 1975), by titrating it against standard EDTA (0.02 N or 0.01M) titrant using Eriochrome Black –T as an indicator. The value of Calcium was determined by the same method applied in the Calcium Hardness. The value of Magnesium was determined after performing calcium hardness; the magnesium was the difference between the total hardness and Calcium Hardness. The amount of chloride ions in the water sample was estimated

by Harvey's method (APHA, 1975) by titrating with $AgNO_3$ solution using Potassium chromate as an indicator. BOD was determined by using direct and dilution methods (Handbook of methods in environmental studies, S. K. Maiti (2001), APHA (1975), Saxena (1987). The Sulphate was determined by Turbidimetric method (APHA, 1975). The total phosphate was determined by Stannous chloride method (APHA, 1975). The Nitrate –N was determined by phenol disulphonic acid method (Saxena, 1887).

7. The zooplankton was collected once in every month. Quantitative samples of zooplankton were collected by filtering sub-surface water through plankton net made of a silk bolting cloth N. 25 (mesh size 0.04m). The plankton obtained will fix in 5% formalin. Enumeration of the individuals' planktons was done on the lines recommended by Welch (1952). Samples were count in a Sedgwik-rafter cell for plankton. The zooplankton groups like Rotifers, Cladocerans, Copepodes and Ostracodes were identified and photographed with Metzer-M-Co-axial Trinocular Digital Research Microscope vision plus-5000 DTM.

8. The phytoplanktons were collected, photographed and identified by standard keys. The macrophytes also were collected, preserved and identified by using pertinent literature. The Benthic macro invertebrates were collected repeatedly, preserved and identified by using pertinent literature. The Ichthyofauna was collected from the ponds during fishing days and identified by referring standard literature. The microbiological investigation obtained with the help of SPC method in microbiology laboratory.

9. The physicochemical properties exert influence both individually and collectively which conditions the origin, development and succession of biotic communities and their interaction producing abiotic environment.

10. The water temperature ranged between 22.2 ^{0}C to 32.2 ^{0}C and seasonally ranges between 25.025°C To 28.8°C in winter and summer respectively. The maximum values of water temperature were observed in summer months and minimum in winter months. Higher temperature in summer season might be due to low water level, greater solar radiation, higher rate of oxidation of organic matter and other anthropogenic activities.

11. The pH is ranged in 7.1 to 7.8. The maximum pH recorded during the summer season might be due to high temperature, clear sunlight and high photosynthesis. The minimum pH recorded in monsoon could be due to inflow of fresh rain water into the pond. It is clear that, the pond is slightly alkaline in nature.

12. The minimum Transparency was observed to the extent of 26.75 cm in the monsoon season might be due to the fine silt, held in suspension as a result of large inflow of runoff from the catchment area decreasing the light penetration, while maximum 31.75 cm in the winter. Higher the transparency value in winter might be due to settlement of very rich dead and decaying biomass.

13. The minimum TDS value of 377.5 mg/l in the winter season and maximum of 512.5 mg/l in the summer season. Maximum TDS in summer season might be due to discharge of domestic sewage from locality and low water level, whereas lower values in winter season might be due to profuse growth of submerged and marginal macrophytes, which might have utilized more dissolved nutrients.

14. The minimum DO value observed was 4.275 mg/l in the summer season and maximum was 6.575 mg/l in monsoon season. The minimum DO in summer might be due to the higher temperature and the high rate of oxygen consumption by oxidizable matter coming in along with the domestic sewage. The decomposition of organic matter was an important factor in consumption of DO. Maximum DO during monsoon might be due to increased flow of water dilution of decomposable matter, higher aeration rate and increased water level due to rainfall, thus the water becomes oxygenated in monsoon due to circulation and mixing by inflow of rain water.

15. The minimum Free CO_2 value observed was 4.125 mg/l in the summer season and maximum was 6.125 mg/l in winter. Maximum free CO_2 in winter may be due to the excessive concentration of biodegradable wastes in the water, mainly through sewage and surface runoff, algal blooms, microbial decomposition of organic matter and also absorption from atmosphere. Minimum value of free CO_2 in summer may be due to very low water level and very high temperature and profuse growth of macrophytes.

16. The minimum Total alkalinity value observed was 134.75 mg/l in the monsoon and maximum was 170.5 mg/l in the summer season. Maximum Total alkalinity in summer might be due to rise in temperature, evaporation, concentration of nutrients and bicarbonates in the particular. Minimum total alkalinity during monsoon and might be due to the dilution of pond water by ran water which ultimately decreases the value of bicarbonates.

17. The minimum Total hardness value observed was 243.75 mg/l in the summer season and maximum was 357.5 mg/l in the winter season. Minimum hardness during summer might be due to complete utilization of carbonate and bicarbonate by phytoplankton during active photosynthesis and maximum hardness during winter might be due to the anthropogenic activity at the bank of pond. Maximum hardness during winter might be due to the anthropogenic activity at the bank of pond. Higher values of total hardness throughout the year which might be due to the continued discharge of domestic sewage which increases the nutrient load in water.

18. The minimum Calcium value observed was 194.75 mg/l in the summer season and maximum was 303.25 mg/l in the winter season. The minimum Magnesium value observed was 49 mg/l in the summer season and maximum was 68.25 mg/l in the monsoon season. Lower Calcium content in summer might be due to its utilization with consequent luxuriant growth of the phytoplankton. Less Magnesium during summer might be due to its utilization by algae, fungi and bacteria for enzymatic transformation, particularly in photo-phosphorylation. The maximum Ca and Mg might be due to receiving large amount of domestic sewage, and anthropogenic activities in the vicinity of the pond.

19. The minimum Chloride value observed was 66.875 mg/l in the winter season and maximum was 71 mg/l in the summer season. Maximum chloride value in summer might be due to lowering of water level and increase of anthropogenic activities. Minimum value in winter season might be due to dilution effect of post monsoon period and high sedimentation rate.

20. The minimum BOD value observed was 15.3 mg/l in the summer season and maximum was 25.5 mg/l in the winter season. Minimum BOD during summer season might be due to the increased temperature and sedimentation load. Maximum BOD during winter season attributed to the release of domestic sewage, human faecal matter in the pond which increases organic load ultimately increasing BOD. High BOD during winter is attributed to immersion of idols of Ganesh, Durga, Sharda, Gauri, Krishna festivals and religious offerings, which are particularly celebrated during post monsoon and early to mid winter season.

21. The minimum Sulphate value observed was 35.725 mg/l in the monsoon season and maximum was 60.975 mg/l in the summer season. Maximum in summer might be due to evaporative loss of water with influx of domestic sewage, containing sulphur compounds and biological oxidation of sulphur containing organic matter and minimum in monsoon might be due to the dilution effect.

22. The minimum Phosphate value observed was 21.975 mg/l in the summer season and maximum was 34.3125 mg/l in the winter season. Minimum Phosphate in summer might be due to the uptake of phosphate by abundance of phytoplankton and maximum values during winter season might be due to the anthropogenic influences contains influx of detergents.

23. The minimum Nitrate value observed was 0.7 mg/l in the summer season and maximum was 2.235 mg/l in the monsoon season. Low value of nitrate during summer may be attributed to the growth of macrophytes. Higher values of nitrate during monsoon may be due to the influx of nitrogen rich water runoff from the catchment area bringing domestic sewage, fecal matter from pond bank and also runoff from nearby agricultural fields.

24. The zooplankton consisted of Rotifera, Cladocera, Copepoda and Ostracoda. The quantitative relationship amongst different groups of zooplankton in Dhukeshwari Temple pond was Rotifera > Cladocera > Copepoda > Ostracoda during the study.

25. The Rotiferans dominated during summer season followed in winter season while minimum during monsoon season. High density of rotifers during summer season might be due to high temperature which is suitable for their growth, reproduction and development and availability of nutrients due to bacterial decomposition. Low density of Rotifers during monsoon season may be attributed to dilution effect, cloudy weather and low temperature while, during winter it may be coincides with a substantial decrease in temperature in the pond. 46 species of freshwater Rotifers belonging to 15 families from 03 orders were recorded. Family Brachionidae was dominant with 11 species; of which genera Brachionus with 09 species and two species of Platyas is recorded.

26. The Crustacean assemblage forms the major part of zooplankton community constituted by the crucial group like Cladocera, Copepoda and Ostracoda and the diversity within groups. 27 species

of order Cladocera were recorded from the 06 families, with highest diversity with 08 species in family Chydoridae and family Aloniae with 08 species. In subclass Copepoda, 04 species were recorded from order Calanoida, 01 species with order Herpacticoida and 01 species with Cyclopoida. 04 species from single family for Class Ostracoda were recorded. Cladocerans were more during the summer season followed by winter and minimum in the monsoon season. Summer maxima may be due to important bio-ecological relationship between macrophytes and zooplankton. Cyclopoids and Cladocerans were found to be associated with increasing productivity. Ostracoda were maximum in summer might be due to higher water temperature, decrease in water level and increased availability of its food. The higher the diversity of Crustaceans may be due to higher the organic matter and nutrient availability in the habitat.

27. The Phytoplanktons (Algae) composed of 38 genera from the 27 families were observed. The Family Desmideaceae has showed dominant with 4 genera (Cosmarium spp, Closterium spp, Cosmocladium spp & Desmidium spp), while Family Selenastraceae family has showed co-dominant with 3 genera (Anikstrodesmus spp, Selenastrum spp, Monoraphidium spp), and some of the 6 family showed 2 genera for each, rest of the 19 families showed single genus.

28. The Benthic Macro-invertebrates (benthos) consisted of Nematodes, Oligochaetes, Insects and Gastropods. The Annelida compose of Nais spp, Aeolosoma spp, Dero spp Limnodriuls spp, and Branchiura sawerbyi. The aquatic insects such as Chironomous larvae recorded in abundance. Laccotrephes maculates, Dragonfly nymph (Libellulidae), were recorded. The Gastropods, Lymnaea spp, Indoplanorbis spp, Vivipara bengalensis were collected.

29. 13 species of Macrophytes were recorded. The marginal weeds Marsilea quadrifolia, Marseilea minuta, Saggitaria spp, Ipomoea aquatica, Ipomoea carnea; emergent weeds like Nymphoides spp, Nelumbo and Nymphaea stellata; submerged like Hydrilla, Utricularia, Ceratophylum while floating weeds like Trapa, Salvinia also were reported.

30. 9 species of Fishes (Ichthyofauna) belonging to 3 orders and 3 families were recorded.

31. SPC analysis after 48 hrs of incubation has value of 3×10^3 cfu / ml.

Conclusion:

1. The studies in limnology have immeasurable values in sustainable development of any freshwater ecosystem and also standpoint of future EIA. In this context the present investigation deals with the study on physicochemical and biological properties.

2. This lentic ecosystem is undergoing several changes due to anthropogenic activities and therefore it is an obligatory need of control its degradation from anthropogenic activities and assures its conservation. Having a glimpse of observation on physicochemical properties, such as Free CO_2, DO, pH, BOD, Nitrate, Phosphate, Sulphate, etc. it is clear that the Dhukeshwari Temple Pond in Deori is quite polluted and may be classified mesotrophic to eutrophic nature.

3. Dhukeshwari Temple pond receives untreated sewage from the localities in its catchment from the several years. The pond receives organic source in the form of religious offerings and idol immersion, every day cloth washing, bathing, other anthropogenic activities increases the organic load.

4. The presence of indicatory species and diversity in zooplankton and phytoplankton was at higher rate indicates the mesotrophic to eutrophic nature of pond. In zooplankton population rotifers were dominated in density with bioindicator species of Brachionus spp. Their growth and population indicates their Mesosaprobic nature of pond. In crustaceans, Ceriodaphnia, Cyclopoid and Calanoid spp indicates productivity of ponds.

5. Occurrence of certain indicator pollution algae viz. Oscillatoria, Spirulina, Mycrocystis, Navicula, Ulothrix, Scenedesmus, Coelastrum, Ankistrodesmus indicates organic enrichment. The weeds like Nymphoides and Nymphaea indicates unpolluted nature of pond also was found abundantly over the water surface. The nutrient enrichment and resultant eutrophication is due to the dominancy of phytoplankton in the pond.

6. The presence of higher number of Oligochaetes and their diversity may be considered as biological indicator of pollution particularly Limnodrilus spp and Branchiura spp and Chironomus larvae; Gastropods spp and nematode spp reveals the polluted nature of the pond.

7. The daily releases of religious offerings from the temple and all kinds of idol immersed from urban localities have been increasing its nutrient load from many years; hence the Dhukeshwari Temple Pond will become eutrophic in the coming years due to high nutrient load.

8. Fish kill was noticed once during study period. Decrease in dissolved oxygen causing developing anaerobic bacteria resulting in infection and fish kill; indicates the pond is under Mesosaprobic condition. The polluted nature of pond is understood by physicochemical and biological properties specially the dominance of bio-indicator species. It is clear from the foregoing account that the Dhukeshwari Temple pond is Mesosaprobic and if proper control measures are not undertaken may become hypertrophied within few years.

9. The microbiological analysis shows higher value than that of recommended indicates microbial load in Dhukeshwari Temple Pond Deori Dist. Gondia.