

LIMNOLOGICAL STUDY IN INDIA: A REVIEW

Pranjali S. Dhomne¹, Pawan U. Gajbe²

1- Research Scholar, Department of Zoology, Shri Mathuradas Mohota College of Science, Nagpur.

2- Professor, Department of Zoology, Shri Mathuradas Mohota College of Science, Nagpur.

ABSTRACT

Limnology has a unique biological importance, which needs to be studied across the whole world. In India, the lakes are contaminated through the discharges from the industrial waste, septic tank disposal, agricultural effluents, waste disposals etc. which causes substantial increase in the pollution status of such lakes. The major factors for deterioration of the water quality are rapid industrialization; indiscriminate use of chemical fertilizers and pesticides in agriculture, the effluent water percolates into the ground and contaminates the groundwater etc. Due to this contamination, the human population suffers from water borne diseases and many more. It is therefore necessary to carry out the limnological study of the water bodies. In this study, biological, chemical, and physical features of water samples in such water bodies are analyzed. This paper focuses on the importance of limnological study and describes various parameters which are to be considered to carry out the limnological study.

KEYWORDS: Limnological Study, Environmental pollution, Contaminants, Physico-chemical parameters.

INTRODUCTION

Water is regarded as the elixir of life. Life cannot be imagined without water. Water is one of the abundantly available substances in nature. It is one of the most important compounds that profoundly influence life [1,2]. It is essential ingredient of human kind, animal and plant life. It is important to all living organisms, most ecological systems, human health, food production and economic development [3-4].

India accounts for about 2.45 per cent of world's surface area, 4 per cent of the world's water resources and about 16 per cent of world's population. The total water available from precipitation in the country in a year is about 4,000 cubic km. The availability from surface water and replenishable groundwater is 1,869 cubic km. Out of this only 60 per cent can be put to beneficial uses. Thus, the total utilizable water resource in the country is only 1,122 cubic km [5-8].

Water quality refers to purity of water, or water without unwanted foreign substances. Water gets polluted by foreign matters such as microorganisms, chemicals, industrial and other wastes. Such matters deteriorate the quality of water and render it unfit for human use [9]. When toxic substances enter lakes, streams, rivers, ocean and other water bodies, they get dissolved or lie suspended in water. This results in pollution of water whereby quality of water deteriorates affecting aquatic systems. Sometimes, these pollutants also seep down and pollute groundwater. [10-12].

Water scarcity is possibly to pose the greatest challenge on account of its increased demand coupled with shrinking supplies due to over utilization and pollution [13].

Groundwater pollution may be defined as the artificial induced degradation of natural groundwater quality. Pollution can impair the use of water and can create hazards to public health through toxicity or through spreading of diseases. Most pollution originates from the disposal of wastewater following the use of water for any of the wide variety of purposes. Thus a large number of sources and causes can modify from groundwater quality, ranging from drainage system, septic tank, agriculture discharges of water in excess amount. In contact with surface water pollution, subsurface water also get polluted. With giving importance of groundwater

resources, efforts are increasing to prevent, reduce and removal of groundwater pollution [14-18].

The possible pollutants in groundwater are virtually limitless. The sources and causes of groundwater pollution are closely associated with human use of water. The principle sources comes under four categories, i.e., municipal, industrial, agricultural and miscellaneous. But the disposal of refuse (domestic & industrial solid waste) is the major source for the groundwater pollution as well as a major environmental problem [17-18].

As per the limnological study, quality of water usually analyzed according to its physical, chemical and biological characteristics. Limnology deals with a detailed analysis of inland water bodies and their

- a) Physical structure
- b) Water cycle
- c) Chemical structure
- d) Biological structure
- e) Nutrient cycling and materials budget
- f) Pollution and degradation

The Physical structure of a lake deals with the

- a) Basin morphometry
- b) Water cycle and hydrodynamics
- c) Turbidity and Light Penetration and
- d) Thermal stratification
- e) Deposition of sediments

The water spreads in the area ranges from a few sq.km to several thousand sq.km. Similarly the depth of a lake may range from a few metres to a kilometer. The term bathymetry refers to the depth of water and its distribution over space. The shoreline of a lake often gets modified depending upon the change in volume of water in the basin [19-25].

The topography of a lake bottom depends on the origin of a lake. The longitudinal profile of a lake basin may have gentle to steep slope depending upon the nature of elongation. The transverse profile depends on the width of a lake [25-28].

Depends upon the structure of a lake basin, following depth zones are recognized.

- 1) Littoral zone - The zone adjacent to the shoreline which is always under the influence of waves and spray is known as the littoral zone.
- 2) Pelagic zone - The zone which is in the middle of a lake located away from the shoreline is known as Pelagic zone.
- 3) Benthic zone - The zone of deep lake water bottom is known as benthic zone.

Due to the peculiar relationship between water temperature and its density, thermoclines layers are formed in the lake. These layers depict the temperature variation with respect to the depth. Water regulates the temperature and climate of the surrounding regions. Lakes cools the land beside it resulting in a cool breeze. The water balance of a lake depends on various factors like

- a) The seasonal inflow of water from the watershed
- b) Outflow of water from the lake
- c) Change in volume of water in storage
- d) Loss due to evaporation and biotic life
- e) Rate of sedimentation and pollution

All these factors are responsible for the maintaining the retention time of water in the lake. This is an important parameter in lake pollution studies and for calculating nutrient

dynamics. The physical structure of a lake is further influenced by the distribution of light, temperature and wind mixing [28-36].

Limnologists classify the water body, based on temperature distribution, into three different layers as

- a) Epilimnion: denoting the upper most layer of warm water which is comprised of uniformly warm and well-mixed water
- b) Metalimnion: The middle layer of water in a lake that marks the transition between the top and bottom layers where temperature changes rapidly with depth. This layer denotes a distinct rate of change in temperature with depth and
- c) Hypolimnion – The bottom layer of water in a lake that is comprised of uniformly cold and relatively undisturbed water is known as **Hypolimnion**. This layer denotes no variation in temperature.

This classification is termed as thermal stratification. All aquatic eco systems are controlled by the physico-chemical and biological properties of water.

Limnologists analyses the following water quality parameters:

1. Temperature
2. Color and odour
3. Turbidity
4. Depth of light penetration
5. Inflow-outflow of water
6. Water in storage

The chemistry of water is analyzed with reference to its major ions like Ca, mg, Na, K, Hco₃, Co₃, No₃ and So₄ Trace elements like Fe, Al, Ni, Co, Cd, Zn, Sr, Hg, Cr, Cu, Pb and Arsenic.

Upto 1887 the study of fresh and saline waters was considered under one discipline. Later, Limnology got uniqueness from oceanography in analyzing mostly the freshwater lakes of continental regions. There are about 304 million standing water bodies worldwide. About 91% of them are less than 1 hectare in area. The scientists specializing in the analysis of lake ecosystems are called as Limnologists.

The temperature of a lake water influences the

- a) biological activity and growth
- b) kinds of organisms that can live
- c) chemistry of water
- d) chemical reactions and
- e) water balance computations

Temperature of lake water governs the kinds of organisms that can live in it. The rate of chemical reactions generally increases at higher temperature which in turn affects biological activity. The morphometry of a lake includes the basins topography, bathymetry, area of water spread and shore line configuration. The following are the morphometric parameters:

1. Mean depth
2. Volume
3. Maximum length
4. Maximum mean width
5. Length of shoreline

The structure of an aquatic ecosystem is controlled by various aspects like its morphometry, inflow outflow of water, quality of water, depth of water column and several other biotic (or) abiotic factors [36-45].

Limnologists also analyse the role of Nitrogen in water bodies which exists in the form of Ammonia, Nitrate, Nitrite, Urea and dissolved organic compounds. These are available to bacteria, fungi and plants [46,47].

The ultimate aim of studying limnology to evaluate the distribution of plants, animals, fungi and bacteria that give to an ecosystem. Organisms are classified based on their sources of energy and also sources of carbon. Limnology deals with the study of viruses, bacteria, fungi and many green plants [48-52].

In addition, a good number of Protozoans, Rotifers, Crustaceans, insects, worms and mollusks, fishes, amphibians, reptiles, birds and mammals live in an aquatic ecosystem. Algal growth as phytoplankton exhibit purposeful daily and seasonal cycles.

Fish are often neglected by limnologist despite their commercial value and ecological importance in the food web. Fish in such bodies are dominated by the bony fish such as perch, front (or) minnows. Fisheries management and conservation are part of limnological analyses.

For all these limnological studies, the amount of water in storage and its seasonal replenishment, the rate of pollutant load and siltation are essential [52-57].

Human activity has greatly influence the rate of eutrophication. Urban land construction activities and dumping of solid wastes result in increased discharge of soil debris into such water bodies to fill them. Limnologist also analyses the distribution of chemicals especially the Nutrients like Phosphates, Nitrates, Potassium etc. not only in water, but also in plants, animals and sediments [57-62].

All life in an aquatic ecosystem depends on the availability of oxygen which is needed for several chemical and biological reactions. Dissolved oxygen is an essential parameter in limnological studies. Oxygen is continually consumed in respiration by both plants and animals and is produced by plant photosynthesis when there is sufficient light and nutrients.

Similarly, Carbon dioxide which is a product of respiration by both plants and animals, provides the Carbon for photosynthesis. Depletion of dissolved oxygen may cause massive death of living organisms including fishes [63-69].

The optical property of water that causes light to be scattered and absorbed rather than transmitted inside is called as Turbidity. Lights ability to pass through water depends on how much suspended material is present. Turbidity is caused when light penetration is blocked by large amounts of silt, micro organisms, plant fibers, dusts and chemicals. Turbidity affects fish and aquatic life. Water plants need light for photosynthesis. If suspended particles block out light, photosynthesis will be reduced. If light levels get too low, Photosynthesis may stop altogether and algae will die [69-75].

Sedimentation is a continuous process in every lake. Washed out materials from soil erosion, Urban and agricultural wastes may bring all sediments into lakes. These contribute for both suspended sediments and bed load sediments [76].

In deep littoral zone, plants grow entirely submerged or with only a small tip breaking the water surface. Plants of this zone tend to have small thin or finely divided leaves. Common plants of this zone are milfoil, coontail, sago pondweed, other thin-leaved pondweed, bushy pondweed, stonewort, water weed and wild celery. Rooted aquatic plants include both the attached and free floating rooted plants [77-82].

Aquatic plants are a natural and essential part of the lake, just as grasses, shrubs and trees are essential for a land. Roots of plants hold the sediments in place reduce erosion and maintain bottom stability. They provide habitat for fish and other organisms [82-87].

LITERATURE REVIEW

The studies carried out by various researchers on limnology in India are reviewed and the presented the same in this section.

Vaishno Devi Karra et al. (2018) in their research on a Review on the studies of Zooplankton in the lotic water of India extensively reviewed the literature available on zooplanktons in lotic water of India which is a long felt necessity in this field. According to them Indians and foreign researchers opted zooplanktons as the subject and carried out the research work. Almost every part of the country has got perennial rivers and diversity of zooplanktons both taxonomically and ecologically. But still there are many rivers and lakes remain unstudied [5].

Shashikant Sitre (2012) assessed the biodiversity of rotifers with respected to the water quality at ambazari lake located in Nagpur district, Maharashtra State. Season wise rotifers were indentified. Due to manmade activities this lake is getting polluted. As per the author if suitable measures are not taken then this lake will be degraded through anthropogenic activities and its water quality will deteriorate which may remain unfit for human use. The author concluded that physico-chemical and environmental factors determines the diversity and density of rotifers [8].

Kumud Paydalwar and Sharda Dhadse (2020) assessed the phytoplankton and zooplankton using Shannon Weiner Diversity Index and Saprobic Score of macroinvertebrates which indicates the contamination and quality of water. These indices indicate the tropic status of the lakes. The authors did this study on the lakes located in Maharashtra state, India, where in they found that Gandhisagar Lake located in this region is highly polluted. Author recommended taking all the appropriate steps to safeguard these lakes [13].

Soudip Karmakar (2021) studied the Phytoplankton and Zooplankton Diversity and Water quality assessment of three ponds in Hooghly District, West Bengal, India, using the physiochemical and biological parameters. The pollution levels of the ponds were determined with the help of Palmer's Indices and were further supported by the physicochemical parameters like pH, TDS, EC, Calcium, Chlorides, Dissolved Oxygen, Phosphates, Nitrates, Bromides and Nitrites. Water temperature positively supports the population diversity of zooplankton in the ponds under study. The domestic sewage must be treated before it is discharge to these ponds. The urban wastewater, which contains several nutrients, not only enriches the phytoplankton diversity in these ponds but also is helpful for pisciculture practices and it improves the local economy [87].

J. Manju Bashini et al. (2017) studied the seasonal dynamics of plankton diversity with reference to physico-chemical conditions in a fresh water pond in temple pond at Thiruvottiyur, Chennai, India. It is observed that the Zooplankton population density was maximum during summer and minimum during monsoon season. Seasonal changes in temperature and nutrient content of water supports the changes in zooplankton community structure. Rise in DO and nutrient levels of nitrate, phosphate and silicate suggested favorable conditions for plankton growth. It is noted that abundance of zooplankton was influenced by many physico-chemical factors and also depends upon the interaction among biological factors. Through the limnological study of the water bodies, author suggested to take all the strategical measures to safe guard the fresh water biodiversity [44].

Ramesh C Sharma (2020) presented the status of biodiversity of freshwater zooplankton of Uttarakhand Himalaya. Uttarakhand using limnology. Dhanaraj B. Goswami (2018) has evaluates the diversity of zooplankton at Chankapur dam, Nashik, Maharastra, India, using limnology. The limnological study on zooplankton diversity of fresh water body was conducted at Junagadh city located in Junagadh district, Gujarat, India by Chirag A. Acharya (2016). Sulata Kar and Devashish Kar(2016) conducted the similar kind of study in Sat beel of Cachar, Assam,

India. B.K. Sharma & Sumita Sharma (2011) studied the Zooplankton diversity of Loktak Lake, Manipur, India. Mariadoss Kalaiarasi et al. (2016) very critically mentioned that Zooplankton has a very important role to play in coral reef ecosystem. They serve as food for corals, various invertebrates and reef fishes, batfishes etc. According to them some fishes are exclusively zooplankton feeders and therefore their abundance is directly linked to the presence of zooplankton [26].

The water quality of Sakkardara Lake situated in Nagpur, M.S., was analyzed by B. S. Tapase, J. L. Tarar and U. S. Ramteke (2015). They stated that the study of phytoplankton is an important aspect of aquatic biology. Aquatic floral species are the indicator of pollution which varies time to time. Physico-chemical factors of such species are studied and the changes in the ecology are recorded in this research work. Significant seasonal variation in physicochemical parameters recorded. It was concluded that the variation in physico-chemical parameters are responsible for the fluctuation in the pollution indicator species diversity of the Sakkardara Lake. All species were reported to be the most important indicators and are effective to assess the changes cause by anthropological activities and lake water body converted in to semieutrophic [48].

Olushola M. Awoyemi et al. in 2014 studied the physico-chemical characteristics of the water. Various parameters like Temperature, pH, Total Dissolved Solids, Total Hardness, Alkalinity, True and Apparent Color, Turbidity, Electrical Conductivity, Chemical Oxygen Demand, Total Organic Carbon, Total Organic Matter, Nitrate, Chloride, Phosphate, Sulphate, Sodium, Potassium, Calcium and Magnesium were analyzed for hand dug well and borehole water as well as river water of the community in Nigeria. It was concluded that the quality of borehole water is much better than that of hand dug wells. The quality of surface water is also above the permissible level [69].

Pronob Kumar Mozumder, et al. conducted qualitative and quantitative analysis of zooplankton in Bangladesh in the year 2010. The qualitative analysis resulted in highest number of zooplankton in a pond and lowest in the river. It is evident from this study that the variation in zooplankton groups depends on the different parameters that exist in the pond ecosystem [35].

CONCLUSION

In the present study the review of the limnological studies carried out in India and abroad is presented. The details of various parameters used by various researchers to carry out the limnological study are discussed. As per this review limnological studies must be carried out in every water bodies to identify the ecosystem in it. It helps in developing environment friendly atmosphere in the society.

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