International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.04, March 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

A study on physico-chemical parameters to determine the pollution status of a warm monomictic lake of Kashmir, J & K, India

[1]Mohd Yaseen Gudoo*, [2]Anuja Gupta, [3]Mohammad Farooq Mir,

[1]Department of zoology Barkatullah University, Bhopal, M. P

[2]Govt. MVM College Bhopal, M.P, India

[2]Hydrobiology Research Laboratory, S.P College, the Constituent College of Cluster University Srinagar, J&K

ABSTRACT

An attempt was made to study some of the ecologically important physico-chemical parameters of water samples collected at three different stations of a warm monomictic lake (Manasbal lake) of Kashmir valley to determine the pollution status of lake and the anthropogenic pressure on the lake. Water samples were examined for a period of six months from July 2016 to December 2016 on monthly basis by following standard methods of APHA 1998. During the study period, it was found that among the examined physico-chemical parameters, Sacchi - disc transparency ranged from 1.3m to 4.2m, the Air temperature ranged from 6.7^0C to 29.5^0C, Surface water temperature ranged from 5.5^0C to 25.7^0C, Dissolved oxygen ranged from 2.3 to 8.6 mgL^{-1}, Free CO_2 ranged from 1.9 to 14.2 mgL-^{1}, Conductivity ranged from 153.0 to 295.0µs cm^{-1}, PH ranged from 8.4 to 9.6, Total Alkalinity ranged from 130 to 240 mgL-^{1}, Total hardness ranged from 114 to 224 µg L-^{1}, Chloride values ranged from 6.9 to 35.6 mgL-^{1}, Total phosphorous ranged from 91.0 to 249.0 µg L-^{1}, Ammonical Nitrogen ranged from 32.0 to 141.0 µg L-^{1}, Nitrate -Nitrogen ranged from 33.0 to 291.0 µg L-^{1},Total Dissolved Solids ranged from 93 mgL-^{1} to 308mg/L, BOD values ranged from 9.3 mgL-^{1} to 42.5mgL-^{1} and values for Iron ranged from 0.11mgL-^{1} to 0.19mgL-^{1}. The analysis of all the fundamental and ecologically important physico-chemical parameters reveal that the studied lake is victim of eutrophication especially at site-2 due to various undesirable anthropogenic activities like input of domestic sewage and agricultural run-off flushed down into the lake from catchment areas.

Key words: Anthropogenic pressure, Eutrophic, Manasbal Lake, Physico-Chemical Parameters, Pollution.

I.INTRODUCTION

Water is an indispensible natural resource bestowed to planet earth, maintains the survival of all the living organisms (Bashir *et al.*, 2016).The beautiful valley of Kashmir is eminent for its beautiful collection of lentic and lotic fresh water bodies including lakes, rivers, ponds, springs etc. These fresh water bodies not only acts as a source of income, food, fodder and drinking water but also provides a habitat to great variety of flora and fauna. Unfortunately, as a result of various unethical and unplanned human activities these freshwater bodies of Kashmir have become ecologically unstable due to which many water bodies have lost their natural charm and have got deteriorated to a greater extent during the last few decades (Ali, 2014). The health and vigor of an aquatic ecosystem is an expression of water quality. The undesirable changes in physico-chemical characteristics of water has become the fundamental cause behind deterioration of aquatic ecosystem (Kim *et al.*,2001).

At present the natural water resources are in a serious threat of getting deteriorated as a result of encroachment, unplanned urbanization and industrialization (Singh and singh., 2007).The undesirable anthropogenic activities have resulted in heavy nutrient loading into water bodies due to which the water quality as well the aquatic life of water bodies have badly affected (Odada *et al*.,2004 and Li *et al*.,2007). It is a matter of grave concern to carry out the limnological studies on the water bodies that were once pouring life to planet earth but are now on the verge of extinction due to pollution loading and have not only become unfit for human consumption but have also become a serious threat for aquatic flora and fauna. If properly managed these water bodies can be beneficially used for various recreational, occupational as well as domestic purposes (Dar *et al*., 2013).The present study has been carried out to study the various ecologically important physico-chemical parameters of water samples collected from a warm monomictic lake (Manasbal lake) of Kashmir valley to determine the pollution status of lake.

II.MATERIALS AND METHODS

Study area

The Manasbal lake is regarded as the supreme gem of all the lakes of Kashmir valley due to its globally recognized natural charm characterized by deep clean water, variety of beautiful flora like pink lilies, lotus etc and attractive mountains encircling the lake. It is the only lake in Kashmir that undergoes stable summer stratification and has been categorized as a warm monomictic lake (Dewan., 2004).The lake is situated at an altitude of 1583m above sea level between geographical coordinates of $34^0$14– $34^0$16'N-latitude and $74^0$40' – $74^0$43' E-longitude. The lake covers an actual area of about 2.81 km^2 with length 5 kms, width 1 km and maximum depth of 13 m with mean depth of about 4.5 m and catchment of about 33km^2. Manasbal lake is considered as the deepest lake of Kashmir valley. The volume of water in lake has been estimated as $12.8*10^6$ m^3. The lake has no major inflow channels and its water supply is mainly maintained by the internal springs of the lake itself and precipitation. From spring to early autumn the Lar Kul- a small irrigational stream which takes off from Sindh Nallah and irrigates the agricultural fields throughout its course, drains in to the lake on its eastern side. The lake has no permanent inlet but has an out-let which connects the lake with River Jhelum. The lake is encircled by many villages among which Manasbal, Kondabal and Jarokhabal are of primary ecological concern as far as the ecology of the lake is concerned (Javid *et a.l*, 2013 and Bhat *et al.*, 2012).

Sampling and Analysis of Physico-Chemical parameters of water samples:

During the present study water samples were collected on monthly basis from July 2016 to December 2016 at three different sites of lake in polyethylene plastic bottles. Water samples were analyzed for various fundamental and ecologically important physico-chemical parameters according to the standard methods of

APHA 1998. Certain variable parameters like Temperature, Transparency, Dissolved oxygen (DO), PH and Free CO_2 were determined on spot during water sample collection, while as the other parameters were determined at the laboratory.

Description of study sites

Site 1 (M1): This site is located towards the eastern side of the lake near Manasbal garden. This site is most disturbed site and is used for shikara service mostly for tourists. This site is charactarised by its shallow nature.

Site 2 (M2): This site is located towards the northern side of lake near Kondabal village. This site receives most of the domestic sewage from local residential area and nutrient load from Lar-kul, a small channel. This site is charactarised by thick macrophytic vegetation of *Ceratophyllum demersum, Myriophyllum spicatum, Hydrilla verticellata* and *Potamogeton lucens.*

Site 3 (M3): This site is located towards the southern side of lake near Jarokhabal village. This site is charactarised by sparse macrophytic vegetation of *Ceratophyllum demersum, Hydrilla verticellata* and *Potamogeton lucens.*

Result and Discussion

Examination of ecologically important physico-chemical characteristics of water are of primary concern in gaining ecological understanding of status of any water body. The results of physico-chemical parameters of water samples collected from Manasbal lake are depicted in Table 1.

Turbidity index (Secchi-disc Transparency)

Transparency is an ecologically important physical characteristic of water which indicates degree to which sunlight penetrate through the water. During the present study the values for transparency ranged between 2.4m (Dec.) ± 1.7m (July) at site-1, 2.5m (Dec.) ± 1.3m (July) at site-2 and 4.2m (Dec.) ± 2.3m (July) at site-3. The sampling site-2 showed lower water transparency values than other two sites due to the heavy organic matter loading into the lake by surface run-off, from kondabal residential area, by Lar-Kul, silt generated by the disturbance of the lake bottom (sediment) as a result the greater turbulence of flood water which comes after heavy rains as well as due to rich macrophytic growth (Bhat *et al*., 2013). Seasonally, the highest value of water transparency occurred in the months of winter at all sampling sites and may be attributed to low suspended organic matter with poor planktonic growth during winter months (Sinha *et al*., 2002).

Temperature

The water temperature reveals clear monthly variations and ranged between 24.5^{o}C (July) ±
5.6^{o}C (Dec.) at site-1, 25.7^{o}C (July) ± 6.3^{o}C (Dec.) at site-2 and 23.3^{o}C (July) ± 5.5^{o}C (Dec.) at site-3.Significant difference were observed in values of temperature between sampling sites. The highest temperature at site-2 is due to the minimum depth of the lake and consequently the volume of water in contact with air at this site. Therefore, a close relationship was recorded between water temperature and air temperature which are in agreement with the findings of Zutshi (1980), Shastri and Pendse (2001) and Eshwaralal and Angadi (2002). Further, water temperature was found negatively correlated with DO (Das., 2000) and transparency (Reid and Wood., 1976).The values for air temperature ranges between 29.5^{o}C (July) ± 7.3^{o}C (Dec.) at site-1, 28.7^{o}C (July) ± 7.0^{o}C (Dec.) at site-2 and 28.2^{o}C (July) ± 6.7^{o}C (Dec.) at site-3.

Dissolved oxygen

Dissolved oxygen is one of the most important ecological parameter in evaluating any undesirable change in quality of water and is essential to regulate metabolic processes of all biotic forms in water. Oxygen concentration of an aquatic ecosystem varies with temperature, salinity, turbulence, photosynthetic activity of algae, higher plants, atmospheric pressure etc. During the present study the DO values ranged from 7.5 mg L^{-1} (Dec) ± 3.9 mg L^{-1} (July) at site-1, 6.8 mg L^{-1} (Dec.) ± 2.3 mg L^{-1} (July) at site-2 and 8.6 mg L^{-1} (Dec.) ± 4.9 mg L^{-1} (July) at site-3.The prominent decrease in DO levels during warmer months and marked increase of DO levels in colder months indicates its inverse relationship with the temperature (Agarwal *et al*., 1976). The lowest value of DO at Sites-2 may be due to the increased amount of organic matter due to agricultural run-off and sewage input into the lake from catchment areas, which needs oxygen for decomposition by various organisms. Such observations coincide with the findings of Yousuf and Shah (1988).

Free carbon dioxide

Carbon dioxide is a basic raw material for photosynthesis process in plants. In an aquatic ecosystems carbon dioxide reacts with water and forms carbonic acid which soon decomposes to form carbonates and bicarbonates, thus altering pH of water. During the present study the carbon dioxide concentration in lake ranged between 2.0 mg L^{-1} (July) ±13.0 mg L^{-1} (Dec.) at site-1, 1.9 mg L^{-1} (July) ±10.3 mg L^{-1} (Dec) at site-2 and 3.9 mg L^{-1} (July) ± 14.2 mg L^{-1} (Dec.) at site-3. Carbon dioxide shows an inverse relationship with pH that is an increase in carbon dioxide concentration in water results in decrease of its pH due to the formation of carbonic acid (Chandler, 1970). Minute change temperature can alter the solubility of oxygen and carbon dioxide in water (Wetzel., 1975). The higher values of CO_2 towards winter may be attributed to the decreasing temperature and addition of heavy organic matter loading from catchment areas of the lake.

Conductivity

Conductivity is the measure of the capacity of a substance or solution to conduct electrical current. The conductivity values indicate the total nutrient level of a water body. Using specific conductivity as an index, values higher than 200 µS/cm reveals higher level of nutrient loading (Rawson.,1960). During the present study, The values for conductivity ranges between 283 µs cm^{-1} (Aug.) ± 194 µs cm^{-1} (Dec.) at site-1, 295 µs cm^{-1} (Aug) ± 273 µs cm^{-1} (Dec.) at site-2 and 173 µs cm^{-1} (Aug.) ± 153 µs cm^{-1} (Dec.) at sit-3 . The enhancement in values of conductivity is a result of periodical sedimentation of decomposing organic matter (Dar *et al*., 2013). A high level of conductivity reveals the pollution status as well as trophic level of the lake (Shashtree *et al*., 1991). Water bodies having conductivity values greater than 500 µS/cm have been classified as eutrophic (Olsen.,1950). According to these criteria, Manasbal Lake is registered under the category of mesotrophic water body. Range of values depicts strong spatial variation in conductivity and may be attributed to varying degree of anthropogenic stress. Higher value of conductivity at site-2 is due to highest pollution level. Furthermore, conductivity is positively correlated with chloride content (Bhat et *al*..2013)

Hydrogen ion concentration (pH)

During the present investigation the PH values of water body were found to be ranged between 9.5 (July) ± 8.6 (Dec.) at site-1, 9.6 (Aug.) ± 8.7(Dec.) at site-2 and 9.2 (Aug.) ± 8.4 (Dec.) at site-3. . Fluctuations in pH seemed to be influenced by the changes in the rate of photosynthesis and decomposition of organic matter as

IJARSE
ISSN: 2319-8354

also reported by Zutshi and Khan (1988) The lowest pH values found during the winter months may be attributed to lower rates of photosynthesis as also reported by Agarkar and Garode (2000). The increased pH values in warm months may be associated with increase in DO produced due to photosynthesis carried by macrophytes (Wetzel, 1975). Further, it was revealed that pH is negatively correlated that is inversely proportional to CO_2 present (colin *et al*., 1998) and positively correlated that is directly proportional to DO activity (Pandit *et al*., 2001)

Total alkalinity

Alkalinity of water indicates its capacity to neutralize acids and is mainly a role of carbonate, bicarbonate and hydroxide content formed due to the dissolution of carbon dioxide in water (Balkhi *et al*., 1987). During present study the total alkalinity values ranged from 179 mg/L (July) ± 223 mg/L (Dec.) at Site-I, 165 mg/L (July) ± 240 mg/L (Dec.) at site- 2 and 130 mg/L (July) ± 161 mg/L (Dec.). Total alkalinity in the water body followed a decreased trend from winter to summer months as also determined by Agarwal and Thapliyal (2005). The enhancement in alkalinity during cold months may be due to the accumulation of bicarbonate ions as the rate of their uptake gets decreased and the decrease in alkalinity in warmer months is due to the decline in bicarbonate ion concentration because of their utilization by luxuriant phytoplanktonic and macrophytic growth. These findings coincide with reports of Sahai and Shrivastava (1976). Total alkalinity has been used as a rough index of lake productivity (Moyle., 1956). The lake water which possess alkalinity values upto 40 mg/L is considered soft water, with 40-90 mg/L is considered as medium hard and with values above 90 mg/L is considered as hard water (Moyle., 1945). Furthermore, alkalinity reveals positive correlations with nitrate and phosphate due to the fact that enhancement in decomposition of organic matter by alkalinity lead to an increases in concentrations of nitrate and phosphate (Bhat et *al*..2013).

Total hardness

Hardness is the expression of concentration of multivalent metallic cations in solution and occurs due to Calcium, magnesium, carbonates, bicarbonates, sulphates, chlorides, nitrates, soap, detergent and organic matter. According to hardness scale of Water Quality Association (Lehr *et al.*, 1980 and Durfor and Becknor., 1964), if hardness values ranged from 0 to 17 mg/L , the water is considered as soft water, if values ranged from17 to 60 mg/L ,water is considered as slightly hard, if values ranged from 60 to 120 mg/L water is moderately hard, if values ranged from 120 to 180 mg/L water is hard and values more than 180 mg/L indicates that water is very hard. During the present study, the total hardness values ranged from 182mg/L (Oct.) ± 151mg/L (Dec.) at site-1, 224 mg/L (Sep.) ± 165mg/L (Nov.) at site-2 and 145 mg/L (Sep.) ± 114mg/L (Nov.) at site-3.Maximum hardness values at site-2 are the result of discharge of sewage and calcium from kondabal area and agricultural wastes brought by Lar-Kul into the lake at this site. Such results are in agreement with the findings of Patil *et al.* (1986). Furthermore, hardness was found positively correlated with calcium and magnesium (Das., 2002)

Chloride content

Chloride content in water is considered as an indicator of organic matter load (Venkatasubramani and Meenambal., 2007 and Thresh *et al.*, 1944). During the present study, chloride concentration fluctuated from 23.3mg/L (July.) ± 9.9 mg/L (Dec.) at site-1, 35.6 mg/L (July) ± 21.0mg/L (Aug.) at site-2 and 14.3mg/L

(July.) ± 6.9 mg/L (Dec.) at site-3. The higher chloride values during summer months especially at site-2 are as result of various anthropogenic activities like washing of clothes, sewage mixing and higher run-off from the catchment area. Such results are in agreement with the findings of Govindan and Sundaresan (1979) who opined that higher concentration of chloride in the summer months could be a due to sewage mixing, increased temperature and higher run-off from catchment. Chloride content is positively corelated with total dissolved solids as they form one of the constituents of dissolved solids. The abundance of Ca and Mg ions are responsible for an increase in chloride hardness (Das., 2002). High chloride content in water body is associated with organic pollution of animal origin (Thresh *et al*, 1944).

Total Phosphorous

Phosphorus is the main cause for eutrophication of an aquatic ecosystem. The primary sources of phosphorous in aquatic ecosystem are domestic sewage, agricultural run-off containing fertilizers and industrial effluents. Phosphorus is a key nutrient that limits primary productivity of water body (Bhat *et al*., 2013).During the study period, the total phosphorous values ranged from 201 µg L^{-1} (July) ± 150 µg L^{-1} (Dec.) at site-1, 249 µg L^{-1} (July) ± 198.0 µg L^{-1} (Dec.) at site-2 and 128 µg L^{-1} (July) ± 91.0 µg L^{-1} (Dec.) at site-3.The higher values of phosphorous especially at site-2 is due to the tremendous flow of domestic sewage, detergents and phosphorous rich agricultural wastes into the lake from nearby residential areas and agricultural fields. Further, phosphorous was found positively co-related with nitrate (Bhat et *al*..2013).

Ammonical-nitrogen

Ammonia is basically a product of decomposition. Higher concentration of ammonia is lethal to aquatic biota. Ammonia toxicity increases with pH because at higher pH most of the ammonia remains in the gaseous form. At low pH toxicity of ammonia decreases due to its conversion into ammonium ions. During the study period, the values for ammonical- nitrogen ranged from 197 µg L^{-1} (Dec.) ± 85 µg L^{-1} (July) at site-1, 141 µg L^{-1} (Dec.) ± 113 µg L^{-1} (July) at site-2 and 66 µg L^{-1} (Dec.) ± 32.0 µg L^{-1} (July) at site-3. The continuous decrease of Ammonical-Nitrogen concentrations in warmer months could be due to its rapid assimilation by phytoplankton and a declined rate of nitrification at higher water temperature ((Ahlgren., 1967 and Pandit., 1999).

Nitrate-nitrogen

The presence of nitrates, a common form of inorganic nitrogen in any fresh water aquatic ecosystem depends on the action of nitrifying bacteria on nitrogen rich agricultural and domestic wastes. Nitrate –nitrogen is an unstable product formed either by nitrification of free ammonia or denitrification of nitrates (Dar *et al*., 2013). During present study, the values for Nitrate- nitrogen ranges from 205 µg L^{-1} (Oct.) ± 119 µg L^{-1} (July.) at site-1, 291 µg L^{-1} (Nov.) ± 181 µg L^{-1} (July) at site-2 and 111 µg L^{-1} (Nov.) ± 33 µg L^{-1} (July) at site-3. The continuous decrease in Nitrate-Nitrogen levels in warmer months could be due to its rapid consumption by autotrophs and a slow rate of nitrification at higher water temperature (Ahlgren., 1967). Higher value of Nitrate –nitrogen at site-2 is due to higher input of nitrogenous wastes into lake at this site.

Total Dissolved Solids (TDS)

In an aquatic ecosystem dissolved solids mainly include carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, calcium, magnesium, sodium, potassium, iron, manganese etc. (Esmaeili and Johal., 2005). During the present study TDS values ranges between 300 mg/L (July) ± 134 mg/L (Dec.) at site-1, 308 mg/L (July) ± 213 mg/L (Dec.) at site-2 and 186mg/L (July) ± 93mg/L (Dec.) at site-3.The higher values of TDS especially at site-2 in July may be as a result of run-off from catchment. Similar findings were recorded Bhat *et al* in 2013 in Anchar lake.

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand (BOD) is the amount of oxygen consumed by microorganisms in stabilizing the organic matter. During present study BOD values ranged from 27.3(July) ± 12.1(Dec.) at site-1, 42.5 (July) ± 17.3 (Dec.) at site-2 and 21.6 (July) ± 9.3 (Dec.) at site-3.The minimum BOD values obtained during winter was due to the decline in temperature leading to decrease in microbial activity and algal bloom (Sachidanandamurthy and Yajurvedi., 2004). Further, BOD showed negative correlation with DO as the latter is utilized in stabilization of organic matter by microbes.

Iron

During present study the calculated values for iron in lake ranged from 0.16 (July) ± 0.11 (Dec.) at site-1, 0.19 (July) ± 0.12 (Dec.) at site-2 and 0.13 (July) ± 0.11(Dec.) at site-3.

Table 1: The maximum and minimum values of various Physico-chemical parameters at three different sites of Manasbal Lake.

S.no.	Parameters	Site-1	Site-2	Site-3
		Max. Min.	Max. Min.	Max. Min.
1	Secchi-disc Transparency (m)	2.4 (Dec.) ± 1.7 (July)	2.5 (Dec.) ± 1.3 (July)	4.2 (Dec.) ± 2.3 (July)
2	Water Temprature (c^o)	22.5 (July) ± 5.6 (Dec.)	25.7 (July) ± 6.3 (Dec)	21.3 (July) ± 5.5 (Dec)
3	Air Temperature (c^o)	29.5 (July) ± 7.3 (Dec.)	28.7 (July) ± 7.0 (Dec	28.2 (July) ± 6.7 (Dec)
4	Dissolved oxygen (DO) mg L^{-1}	7.5 (Dec) ± 3.9 (July)	6.8 (Dec.) ± 2.3 (July)	8.6 (Dec.) ± 4.9 (July)
5	Free Carbon dioxide (CO^2) mg L^{-1}	13.0 (Dec.) ± 2.1(July)	10.3 (Dec) ± 1.9 (July)	14.2 (Dec.) ± 3.9 (July)
6	Conductivity (µs cm^{-1})	283 (Aug.) ± 194 (Dec.)	295 (Aug) ± 273 (Dec)	173 (Aug.) ± 153 (Dec)
7	Hydrogen ion concentration (PH)	9.5 (July) ± 8.6 (Dec.)	9.6 (Aug.) ± 8.7(Dec.)	9.2 (Aug.) ± 8.4 (Dec.)
8	Total Alkalinity	223 (Dec.) ± 165 (July)	240 (Dec.) ± 179 (July	161 (Dec.) ± 130 (July)

	mg L^{-1}			
9	Total Hardness mg L^{-1}	182 (Oct.) ± 151 (Dec.)	224 (Sep.) ± 165 (Nov.)	145 (Sep.) ± 114 (Nov.)
10	Chloride value mg L^{-1}	23.3 (July.) ± 9.9 (Dec)	35.6 (July) ± 21(Aug.)	14.3 (July) ± 6.9 (Dec.)
11	Tot. Phosphorous µg L^{-1}	201 (July) ± 150 (Dec.)	249 (July) ± 198 (Dec.)	128 (July) ± 91 (Dec.)
12	Ammonical Nitrogen µg L^{-1}	197 (Dec.) ± 85 (July)	141 (Dec.) ± 113 (July)	66 (Dec.) ± 32 (July)
13	Nitrate-Nitrogen µg L^{-1}	205 (Oct.) ±119 (July.)	291 (Nov.) ± 181 (July)	111 (Nov.) ± 33 (July)
14	Total dissolved Solids mg/L (TDS)	300 (July) ± 134 (Dec.)	308 (July) ± 213 (Dec.)	186 (July) ± 93 (Dec.)
15	Biochemical oxygen demand (BOD) mg/L	27.3 (July) ±12.1 (Dec.)	42.5 (July) ± 17.3 (Dec.)	21.6 (July) ± 9.3 (Dec.)
16	Iron mg/L	0.16 (July) ± 0.11 (Dec.)	0.19 (July) ± 0.12 (Dec.)	0.13 (July) ± 0.11 (Dec.)

III.CONCLUSION

From the present study it is concluded that Manasbal is a victim of heavy pollution. The undesirable values of the physico-chemical parameters determined in the present study indicate the Eutrophic status of the Lake especially at site-2. It is quite obvious from the study that various undesirable anthropogenic activities like input of sewage and agricultural wastes into the lake from catchment areas are the main causes behind the deterioration of water quality of the lake. Hence, the present study urges for the implementation of immediate remedial measures from both governmental as well as local public sectors for protection and conservation of the lake from further deterioration.

IV.ACKNOWLEDGEMENT

I express my gratitude to Dr. Mohammad Farooq Mir (Prof. & Head Hydrobiology Research Laboratory Govt. S. P College (The constituent college of Cluster University Sgr), Kashmir and Dr. Anuja Gupta (Prof. Govt. MVM Bhopal M. P) for their constant whole hearted guidance and encouragement throughout the Research programme. Last but not least, I am grateful to other Research Scholars of HRL for their valuable cooperation.

REFERENCES

[1] M. Bashir, R. Chauhan, M. F. Mir, Ashraf. M. Ashraf, N. Amin, S. A. Bashir and M. Y. Gudoo. To evaluate pollution studies in relation to the water quality status of Anchar lake Srinagar Kashmir. *Journal of Environmental Science, Computer Science and Engineering & Technology* , 6(1), 2016, 17-23.

[2] Ali. U. Stress of Environmental Pollution on Zooplanktons and their Comparative Studies in Dal Lake, Wular lake,Anchar lake and Manasbal Lake in Srinagar,Kashmir. *The International Journal Of Engineering And Science (IJES)*, 3)8), 2014, 39-44.

[3] A. P. H. A. Standard Methods for the Examination of Water and Waste Water. 20th ed. American Public Health Association, Washington. D. C, 1998.

[4] N. K. Agarwal and Thapliyal, B. L. Thapliyal. Preimpoundment hydrological study of Bhilangana river from Tehri Dam reservoir area in Uttaranchal, *Enviromental Geochemistry,* 8, 2005, 143-148.

[5] D. K. Agarwal, S. D. Gour, I. C. Tiwari, S. Narayan and S. M. Narwash. Physico-chemical characteristics of Ganga water in Varanasi. Indian, *Journal of Environmental Health*, 18, 1976, 201-206.

[6] S. V. Agarkar and A. M. Garode. Evaluation of physico-chemical and microbiological parameters of Vyazadi reservoir water, *Indian Hydrobiology*, 3, 2000, 3-5.

[7] I. Ahlgren. Limnological studies of Lake Norrviken, a eutrophicated Swedish lake. Schweiz. Z. *Hydrology*, 29, 1967, 53-90.

[8] S. A. Bhat, G. Meraj, S. Yaseen, A. R. Bhat and A. K. Pandit. Assessing the impact of anthropogenic activities on spatio-temporal variation of water quality in Anchar lake, Kashmir Himalayas**.** *International Journal Of Environmental Sciences,* 3(5),2013, 1625-1640.

[9] M. H. Balkhi, A. R. Yousuf and M.Y. Qadri. Hydrobiology of Anchar Lake, Kashmir. *Comp. Physiol. Ecol* 12, 1987, 131-139.

[10] Chandler, J. R. Chandler. A biological approach to water quality management. *Water Pollution Control,* 69, 1970, 415-422.

[11] N. Colin, H. Martin and W. J. Richard. Dissolved carbon dioxide and oxygen in the River Thames: Spring–summer 1998, *Science of the Total Environment*, 1998, 210-211 and 205-217.

[12] J. A. Dar, M. F. Mir, N. A. Bhat and M. A. Bhat. Pollution studies of a monomictic lake, Srinagar, Jammu and Kashmir, India. *Forest Journal*, 2(1), 2013, 1-5.

[13] A. K. Das. Phytoplankton primary production in some selected reservoirs of Andra Pradesh, *Geobios,* 29, 2002, 52-57.

[14] P. Dewan. Jammu, Kashmir and Ladakh. Govt. of J & K Manas Publications, New Delhi. 2004.

[15] C. N. Durfor and E. Becker. Survey Water Quality Paper 1812, 1964, 1-364.

[16] S. Eshwarlal and S. B. Angadi. Primary productivity of two freshwater bodies of Gulbarga, India, *Natural Environmental Pollution Technology*, 1, 2002,151-157.

[17] H. R. Esmaeili and M. S. Johal. Study of physico-chemical parameters of water of Gobindsagar reservoir, India. In*:* Proceeding of National Seminar on New Trends in Fishery Development in India. Punjab University, Chandigarh, India. 2005.

[18] Govindan and B. B. Sundaresan. Seasonal succession of algal flora in polluted region of Adyar river. *Indian Journal of Environment and Health*, 2, 1979, 131-142.

[19] B. Kim, J. Park, G. Hwang, M. Jun and K. Choi (2001).*Limnology*,2, 2001, 223-229.

[20] J. H. Lehr, E. G. Wayne and D. Jack. Toxic inorganics and other Constituents. In: Water Pollution-Causes effects and control, New age International (P) Limited, New Delhi, 1980, 192-194.

[21] R. Li, M. Dong, Y. Zhao, L. Zhang and Q. Cui. Aassesment of water quality and identification of pollution sourcesof pleatue lakes in Yunan (China).Journal of Environmental Quality,36, 2007, 291-297.

[22] J. B. Moyle. Relationship between the chemistry of Minnesota surfacewaters and wild life management. *J. Wild Mgt.*, 20, 1956, 303-320.

[23] J. B. Moyle. Some chemical factors influencing the distribution of aquatic plants in Glubokoe in relation to predation and composition. *Hydrobiol*. 141, 1945, 33-43.

[24] E. O. Odado, D. O. Olago, K. Kulindwa, M. Ntiba and S. Wandiga. Mitigation of environmental problems in lake Victoria, East Africa: casual chain and policy options analyses.*Ambio*.33, 2004, 13-23.

[25] S. Olsen. Aquatic plants and hydrospheric factor, I. Aquatic plants in Switzerland, Arizona, *Journal of Sevensk. Botanisk Tidskriff*, 44, 1950, 1-34.

[26] A. K. Pandit, S. A. Rathore and S. A. Bhat. Limnological features of freshwater of Uri, Kashmir, *Journal of Research and Development*, 1, 2001, 22-29.

[27] A. K. Pandit. Trophic structure of plankton community in some typical wetlands of Kashmir, India. Limnological Research in India (SR Mishra) Daya Publishing House. Delhi, 1999, 190-224.

[28] M. K. Patil, N. Usha and K. S. Unni. On Water Quality around Urban Ecosystem, (Ed.) K.S. Unni, 1986, 222.

[29] G. K. Reid and R. D. Wood. Ecology of Inland Waters and Estuaries. Second edition. D.Van. Nostrand. Co., New York. 1976.

[30] D. S. Rawson. A Limnological comparison of twelve large lakes in Northern Saskatchewan.*Limnol.Oceanogr* 5, 1960, 195-211.

[31] R. Sahai, V. C. Srivastava. Physico-chemical complexes and its relationship with macrophytes of Chilka Lake. *Geobios* 3, 1976, 15-19.

[32] K. L. Sachidanandamurthy and H. N. Yajurvedi. Monthly variations in water quality parameters (physico-chemical) of a Perennial lake in Mysore city. *Indian Hydrobiology*, 7, 2004, 217-228.

[33] N. K.Shashtre, M. S. Islam, S. Pathak and M. Afshan. Studies on the Physico-chemical dimensions of the lentic hydrosphere of Ravindra Sarover (Gaya). Incurrent trends in Limnology. (Nalin K,Shashtreed). Narender Pub. House, N. Delhi. 1991, 132-152.

[34] R. K. Singh and K. N. Singh. Physico-chemical and biological analysis of Gomati river water affected by urban wastes. *Mar. Sci. Res. India*, 4(2), 2007, 233-236**.**

[36] Y. Shastri and D. C. Pendse. Hydrobiological study of Dahikhura Reservoir. *Journal of Environmental Biology*, 22(1), 2001, 67-70.

[37] M. P. Sinha, R. Kumar, R. Srivastava, S. K. Mishra and A. K. Choudhuri. Ecotaxonomy and biomonitoring of lake for conservation and management. Biotic Profile In: Ecology and Conservation of Lakes, Reservoirs and Rivers. Vol. II. Edited by Arvind Kumar 248-289 (ABD Publication Jaipur, India). 2002.

[38] J. C. Thresh, E.V. Suckling and Beale, J. E. Beale. The Examination of water and water supplies. (EW Taylor) London. 1944.

[39] A. R. Yousuf and G. M. Shah. Comparative Limnology of some fresh habitats of Kashmir. *Geobiosphere*, 7, 1988, 58-61.

[40] R. Venkatasubramani and T. Meenambal. Study of sub-surface water quality in Mattupalayam Taluk of Coimbatore district Tamil Nadu. *Natural Environmental Pollution Technology*, 6, 2007, 307-310.

[41] R. G. Wetzel. Limnology. Mc-Graw Hill Book Co. Inc, New York 1975, 538.

[42] D. P. Zutshi, B. A. Subla, M. A. Khan and A. Wanganeo. Comparative limnology of nine lakes of Jammu and Kashmir Himalayas. *Hydrobiologia*, 80, 1980, 101-112.

[43] D. P. Zutshi and M. A. Khan. Eutrophic gradient in the Dal lake, Kashmir. *Indian J. Env.Health* 30, 1988, 4.