Comparative Study of Water Chemistry in two Morphologically Dissimilar Rural Lakes of Kashmir Himalaya

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ABSTRACT

The present paper describes the work carried out on two morphologically dissimilar Lakes of Kashmir Himalaya. The physco-chemical parameters assessed, shows considerable variation. It has been recorded that Mansbal, an open drainage type of lake, flashes out an equal volume of water in one and a quarter of year. While as Bod-sar is closed type of lake, on contrary does not flash much water (no flashing rate) has maximum detention period, so nutrient retention period is high which support the metabolic phenomenon within the lake. Mansbal is a warm monometic lake and develops summer stratification while no such phenomenon is evident in Bod-sar (Wanganeo *et. al.* 2006).

Mansbal Lake shows vertical stratification profile of dissolve oxygen that is of clinograde type, it has been also observed that there is a gradual reduction in Hypolimic oxygen in lake while no such phenomenon was observed in the Bod-sar Lake because of shallow depth. (Wanganeo *et. al.* 2006).

The concentration of free carbon dioxide supports the decomposition rate at the sediment water interface in the Bod-sar. While in Mansbal, the free carbon dioxide concentration is very less. Free carbon dioxide tension being under the direct influence of photosynthetic action, and high metabolic process drives the pH from acidity towards the alkalinity in Bod-sar. In Mansbal, pH is driven from neutrality towards the alkalinity. Conductance being principal function of ions, witness seasonal trend in both the lakes. Fall in salt concentration during summer is conceptive with least electrically conductivity of water.

Nutrients in both the lakes are highly dynamic because it may be utilized, stored transformed and excreted repeatly by various aquatic organisms. The variations in phosphorous content are likely to be the influence of catchments interaction and other autochthonous phenomenon (When sediment water interface becomes anoxic in such type of productive ecosystem the oxidized micro zone formed below is lost which induce the phosphorus release in both lake waters at rapid rate). In Bod-sar the bacterial metabolism of organic matter is the primary mechanism by which orthophosphrous is converted in to phosphate. All forms of nitrogen show seasonal trend. Magnesium and sodium are relatively conservative in nature, concentration are abundant because it is relative unaffected by metabolically alternate reduction and oxidation concentration of

waters. Silicate has marked influence on the productivity and succession of algal population. The amount of silicates is less in Mansbal and high in Bod-sar, hence supporting the ecological succession and productivity of Bod-sar.

The data on the water chemistry clearly reveals that there were great temporal variations in most of the parameters while few parameters fluctuated between the narrow ranges in both the lake there is insignificant spatial fluctuation in the study.

INTRODUCTION

Management of lakes should be determined on consideration of its significance for conservation, on which basis the management priorities should be clearly spelt out. Management requires an in-depth knowledge of mechanisms and phenomenons occurring within and around the system.

Physico chemical parameters play a vital roll in determining qualitative abundance distributional pattern and inter relationships among biotic and a biotic systems. To provide habitat for many species, water quality plays imperative role in determining the rich diversity, change in water quality exert a selective action on flora and fauna, which constitutes the living population of water. Lakh are potential ecosystem showing dynamic phenomena's that are favorable or unfavorable to most of the structural elements of lakh ecosystem. Unusual prosperity of water and its interaction with surroundings environment have discernible effect on its ecology. Structure based on the morphometry drainage basin and physiochemical properties of water give additional form to system. Super imposing these components give another type of origination. The fresh water of the biosphere is extremely limited and out of the total, less than one percent is available to us. During recent years, there is a growing concern for the conservation and management of our aquatic ecosystem. Present communication is an extensive investigation to work out the characteristics of water in two lakes that are morphologically dissimilar, in terms of its physco-chemical features in detail to provide the basic data for various conservational programs to be undertaken from time to time for the management of lakes.

STUDY AREA

Two lakes were selected for the present investigations, Manasbal Lake and Bod-sar. Both are rural valley lake, situated geographical co-ordinates of 34^0 15' N 74^0 40' E and 34^0 1' N 74^0 55' E respectively. With an area of 2.81 Km^2 and 0.102 Km^2 .The maximum depth is around 11.8m and 2.35 min Mansbal and Bod-sar respectively. Manasbal is towards North of Srinagar city at a distance of about 32 km. The peripheral areas of Mansbal are covered with variety of macrophytes and centre has clear water. Bod-sar is situated in the south of Srinagar city at a distance of 13 Km having hight anthropogenic pressure from the catchment. Mansbal is at an altitude of 1584m (a.s.l) is the deepest of all valley lakes; it drives its water chiefly from springs spread over its basin.

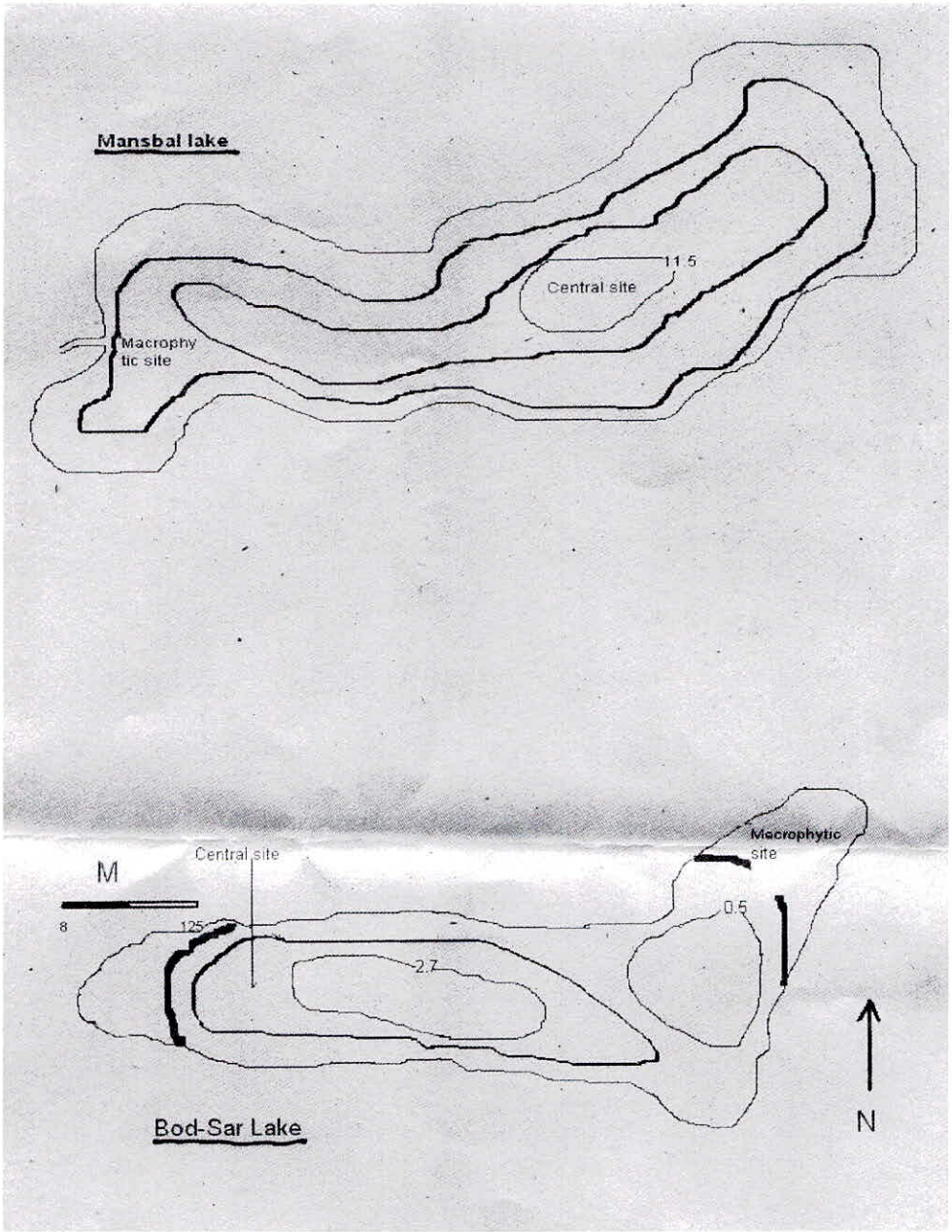

Fig. 1 : Show Maps of two Lakes

MATERIAL AND METHODS

Water samples collected for physco-chemical analysis were transported to the laboratory, methods for analysis were followed from A.P.H.A (1998), Golterman, and Clymo (1969) .The samples were collected on monthly basis. Water samples were collected by dipping one liter polyethylene canes just below the surface water. Temperature, Weather, Dissolve oxygen, Conductivity, pH, and Free CO_2 was determined on the field.The other parameters were determine in the laboratory within 24 hours of sample collection.

RESULT AND DISCUSSION

Water quality is one of the key factor governing the life in lentic ecosystem. A persual of the physco-chemical data indicate significant variation throughout the study. All the parameters are discussed below.

Water temperature

The water temperature recorded ranges from 6 ^{0}C to 29^{0}C in mansabal lake and in Bod-sar lake ranges from 9^{0}C to 30^{0}C . Water temperature belongs to important factors affecting metabolism, growth, reproduction, emergence, and distribution of aquatic insects (VANNOTE & SWEENEY 1980).Thermal stratification which contribution so much to lakh is a direct result of temperature. Temperature is very important event in lakh ecosystem. Mean temperature does not show much variation but play vital role in the lake metabolism, Mansbal is mainly controlled by temperature, as it is a monomitic lake. Stratification occurs due to temperature variation during different seasons such phenomenon is not seen in Bod-sar. However, temperature also controls various mechanisms in Bod-sar.

Conductivity

Conductance being principal function of ions, witness seasonal trend in both the lakes. Fall in salt concentration during summer is conceptive with least electrically conductivity of water. Conductivity ranges from110-396µS in Mansbal and 255-515µS in Bod-sar. Conductivity shows great variation on comparing. Mansbal has low value indicating low impurity and low ions in water. As in Bod-sar has very high value indicating high interference has high eutrophic status. The above trend is also observed by Wanganeo *et. al.* in 2004.

pH

pH : strength of Hydrogen ion in solution, pH makes more sense , since the hydrogen ion H^+ controls the acidity of a system. Water was neutral to alkaline in Mansbal, and in Bod-sar waters was acidic to alkaline. pH ranges from 7-9.2 in Mansbal and 6.7 - 9.1 in Bod-sar. In Bod-sar shows wide range of pH, high pH in Bod-sar is due to photosynthesis

of macrophytes and algae. Waters of these lakes exhibit wide variations in the relative acidity and alkalinity, not the actual pH value, but also in the total amount of dissolved material producing the acidity or alkalinity. The concentration of these compounds and the ratio of one to another determine the observed pH and the capacity for buffering capacity of given water bodies.

Free carbon dioxide

The amount of free carbon dioxide in Bod-sar was markedly higher than that of Manasbal. The average value of carbon dioxide was 1.25 to 16.1 mgl^{-1} in Manasbal and 2.5-50 mgl^{-1} in Bod-sar. The concentration of free CO_2 is under the influence of photosynthetic action of planktons and macrophytes. Free co_2 was absent in Bod-sar during summer months because macrophytes and planktons utilize it during the process of photosynthesis, and during winter the free co_2 was high because it is not utilized by planktons and macrophytes as they are not abundantly present.

Total alkalinity

Total alkalinity ranges from 52 mgl^{-1} to 136 mgl^{-1} in Mansbal.102-265 mgl^{-1}. Moderatly high alkalinity was predominatlly due to Carbonate and bicarbonates of calcium. Total alkalinity can be directly associated with temperature and pH.

Dissolve Oxygen

The concentration of Dissolve oxygen varied appreciably among the two lakes, the average values recorded are anoxic bottom to 15.36 mgl^{-1} in mansbal lake and in bod-sar the average values were 0.48 to 10.45 mgl^{-1}. Oxygen plays a very important role in lake metabolism, intense decomposition rate in the sediments interface leaves the water near anoxic in Bod-sar lakes. The high DO values recorded in the water coloum is directly related to the abundance of planktons and macrophytes, which undergoes vigorous phoyosynthesis leading to the super saturated condition of water at surface waters and the bottom waters are generally cent percent deficit in DO values in Mansbal lake. Anoxic condition of bottom surfac in mansbal was also reported by Wangneo *et. al.* 2004. the presence of macrophytesin waters help in supersaturation the upper layers of lake water with oxygen produced by green plants in water is five times greater than that of oxygen from the air (Wetzel,1975 and Voznaya, 1981).

Chloride

Chloride fluctuates in the range of 3-50mgl^{-1} in Manasbal and in Bod-sar, the range lies between 20-70 mgl^{-1}. High amount of chloride in both the lakhs, pointings towards the organic pollution and sewage interference. In Bod-sar lakh the high chloride content is attributed by high in flow through direct preparation and run of from high-urbanized catchment. Pandit 1999 attribute high chloride content in Hokersar wetland. High chloride content is also reported by Wanganeo 2004 in Bod-sar and Manasbal.

Calcium and Magnesium

Water in both the lakes is calcium rich. Owing to lacustrine depositions, the calcium was recorded 6.2 to 84.4mgl^{-1}and 8.9-91mgl^{-1} in Manasbal and Bod-sar respectively. The most dominating cation in the Kashmir Himalayans lakes is calcium (Zutshi *et. al.* 1980) so is in both lakes. When CO_2 dissolves in water, a small fraction is hydrated to form carbonic acid (H_2CO_3) which dissolves the calcium carbonate, forming the calcium bicarbonate, neutrilizing the water and increase the Ca^{++} concentration in the lakes, this event is one of the causes that the Mansbal and Bodsar are Calcium rich lakes. (Ohle 1934). The precipitate of solid calcium carbonate during period of high photosynthesis are formed in the waters, this preciptated, whitish grainules of calcium carbonate are deposited on higher aquatic plants, encapsulate the leaves and stem. As seen in manasbal.Magnesium fluctuated in the range of 0.12 to 20.2mgl^{-1}in Manasbal and in Bod-sar it is 0.09 to 15.9 mgl^{-1}. Magnesium does not show any significant concentration in both the lakes, least concentration of magnesium is precipitated with bicarbonates depicting low concentration through out the year.

Nitrate-Nitrogen

Nitrate is most important and only major available form of nitrogen to living systems. Nitrate, the most common form of combined nitrogen in lake. (Cole 1975) ranges from15-330 µgl^{-1} in Mansbal and in Bod-sar, the range is 40 to 560µgl^{-1}. Bod-sar is a shallow lake were bacterial nitrification often results in abundance of nitrate. Nitrate may increase, when oxygen is abundant and ammonia is converted into nitrate by bacteria, consuming the energy. Sediments rich in nitrogen, contributes appreciably towards the nitrate concentration under high oxygen concentration. Nitrification is more rapid in well-oxidized and well-buffered calcareous sediments. These findings are total agreement with the findings of Serruya *et. al.* (1974).

Total Phosphate

It is found within the range of 1.53 - 80.88 µgl^{-1} in Mansbal and 5.23to 100.25µgl^{-1} in Bod-sar. Phosphate concentration is less in Manasbal than in Bod-sar. Phosphate levels in Mansbal Lake often fall to extremely low levels. Phytoplanktons are only able to use phosphate form (PO_4) for growth, which results in depilation of phosphate in lake. Phosphate is much released from sediments than from water solution. The variations in phosphorous content are likely to be the influence of catchments interaction and other autochthonous phenomenon (When sediment water interface becomes anoxic in such type of productive ecosystem the oxidized micro zone formed below is lost which induce the phosphorus release in both lake waters at rapid rate). In Bod-sar, the bacterial metabolism of organic matter is the primary mechanism by which orthophosphrous is converted in to phosphate. Direct sediment resupply of phosphate in Mansbal is initiated often. A study on phosphate supply of some lakes led Kerekes 1975 conclude, that lakes

Table 1 : Water chemistry of Lakes studied

Sno.	Parameters	Lakes	site	Mean	Range
1	Temperature ^0C	Mansbal	I	16.50	6.0-27.0
			II	16.40	6.5-26.3
			III	18.10	7.2-29.0
			IV	17.85	6.6-29.1
		Bod-sar	I	17.50	6.0-29.0
			II	19.00	8.0-30.0
			III	17.70	7.3-28.3
			IV	19.50	9.0-30.0
2	Conductivity µS	Mansbal	I	183.00	110-256
			II	296.00	223-396
			III	217.00	189-245
			IV	219.00	69-396
		Bod-sar	I	385.00	255-515
			II	512.50	510-515
			III	484.00	456-512
			IV	505.00	499-511
3	pH	Mansbal	I	7.75	7.0-8.5
			II	8.20	7.4-9.0
			III	8.25	7.3-9.2
			IV	8.45	7.7-9.2
		Bod-sar	I	7.65	6.7-8.6
			II	7.95	6.9-9.0
			III	7.90	6.7-9.1
			IV	7.90	6.7-9.1
4	FreeCO_2 mgl^{-1}	Mansbal	I	7.775	1.25-14.3
			II	9.04	1.98-16.1
			III	7.09	1.58-12.6
			IV	8.975	1.85-16.1
		Bod-sar	I	18.95	2.5-35.4
			II	26	6.6-45.4
			III	26.3	2.6-50.0
			IV	27.45	4.9-50.0
5	Total Alkalinity mgl-1	Mansbal	I	104	52-156
			II	97	45-146
			III	103	52-154
			IV	107.5	59-156
		Bod-sar	I	179	100-258
			II	182.5	101-264
			III	181	102-260
			IV	183.5	102-265

Table 1 : Water chemistry of Lakes studied (Contd....)

6	Dissolve Oxygen mgl^{-1}	Mansbal	I	8.93	2.5-15.36
			II	8.6	4.8-12.4
			III	9.33	3.3-15.36
			IV	4.1	1.5-6.7
		Bod-sar	I	2.525	0.45-4.6
			II	7.875	5.3-10.45
			III	5.25	1.9-8.6
			IV	4.55	3.2-5.9
7	Chloride mgl^{-1}	Mansbal	I	24	3.0-45
			II	27.5	5.0-50
			III	34	18-50
			IV	37.5	25-50
		Bod-sar	I	39	20-58
			II	48	29-67
			III	45	20-70
			IV	46.5	28-65
8	Calcium mgl^{-1}	Mansbal	I	45.3	6.2-84.4
			II	44.7	7.4-82.0
			III	46.5	6.9-80.9
			IV	46.45	8.9-84.0
		Bod-sar	I	49.53	8.9-90.1
			II	50.45	9.9-91.0
			III	49.45	8.9-90.1
			IV	51.25	11.5-91.0
9	Magnesium mgl^{-1}	Mansbal	I	10.16	0.12-20.2
			II	9.855	0.11-19.6
			III	10.06	0.12-20
			IV	10.19	0.18-20.2
		Bod-sar	I	7.995	0.09-15.9
			II	6.85	0.10-13.6
			III	8.045	0.19-15.9
			IV	7.9	0.9-14.9

Table 1 : Water chemistry of Lakes studied (Contd....)

10	Nitrate-Nitrogen μgl^{-1}	Mansbal	I	172.5	15-330
			II	725	150-300
			III	139.5	45-234
			IV	210.5	100-321
		Bod-sar	I	427	294-560
			II	201	45-356
			III	418.5	298-539
			IV	202.5	40-365
11	Total Phosphateμgl^{-1}	Mansbal	I	41.21	1.53-80.88
			II	40.89	1.45-80.32
			III	32.56	5.31-59.8
			IV	45.41	10-80.81
		Bod-sar	I	52.37	5.23-99.5
			II	66.53	32.8-100.25
			III	73.31	52.3-94.32
			IV	53	5.89-100.1
12	Iron μgl^{-1}	Mansbal	I	1703	26.0-3380
			II	1685	39.0-3330
			III	1671	356-2986
			IV	1647	29.7-3265
		Bod-sar	I	2676	132-5220
			II	2317	35.6-4598
			III	2359	35-4682
			IV	1850	40-3659
13	Sillicatesμgl^{-1}	Mansbal	I	8.125	1.25-15
			II	8.925	4.6-13.25
			III	7.32	1.25-13.39
			IV	9	3.1-14.9
		Bod-sar	I	23.83	2.66-45
			II	40.55	36.1-54.0
			III	31.6	12.3-50.9
			IV	34.55	19.5-49.6

with shorter water renewal times were less vulnerable to pollution than lakes with lower flushing rates, it is also with the studied lakes.

Iron

Iron is required in moderate quantity in lake. Iron lies in the range of 26.0 to 3380 μgl^{-1}in Manasbal and 35.654 to 5220μgl^{-1} in Bod-sar. There are number of factors that attributes to high concentration of iron in both the lakes. Anoxic condition and low Redox potential reduce the ferric iron to more soluble ferrous iron and alter the balance in the lakes, resulting in release of large quantity of ferrous iron. Diel vertical migrations of aquatic microorganisms change Iron levels by up taking or excreting the iron. Phosphate is commonly considered as an important precipitating agent of iron, and the two nutrients may scavenger each other by adsorption each other (phosphate on ferric hydroxide) from lake waters. (Mortimer 1971).

Silicate

The main source of silicate is from watershed in to the lake and lake sediments. The average concentration of silicate is about 1.25 to 15 mgl^{-1}in Mansbal and 2.66 to 54 mg^{-1} in Bod-sar. Silicate has marked influence on the productivity and succession of algal population. The amount of silicates is less in Mansbal and high in Bod-sar, hence supporting the ecological succession and productivity of Bod-sar. Silica exists in many forms in both the Lakes but only Sililic Acid (H_2SiO_4), which is partially dissociated at normal pH, and is utilized by Algae, as stated by Lewin, 1962 and Darley, 1974.

CONCLUSION

The data on the water chemistry clearly reveals that there were great temporal variations in most of the parameters while few parameters fluctuated between the narrow ranges in both the lake there is insignificant spatial fluctuation in the study.

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