A Comparative Study of Temperature, DO and BOD in Mansar and Renuka Lakes of Western Himalayan Region (India)

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ABSTRACT

In the present study, Temperature, Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) were monitored in the Mansar and Renuka lakes located in the Western Himalayan Region. The results have shown that DO profiles seem to mimic the trend of thermal profiles under the same periods. Further, stratification of the lake during summer and mixing condition during winter months is clearly visible. DO and BOD values indicated that bottom layers of these lakes remain mostly under anoxious condition (DO < 6.0 mg/l) throughout the year. Based on thermal behavior, both these lakes could be classified under monomictic type of lakes having one overturn of water in a year.

Low temperature from top to bottom coupled with DO below 4.0 mg/l, may also be a reason for frequent fish mortality in these lakes reported during winter months. In view of DO deficit, suitable artificial measures are required to keep adequate DO levels for maintaining ecological balance in the system.

INTRODUCTION

The increasing population, high production agriculture, development of industries, and various other domestic and recreational uses of water have forced the scientific and engineering communities to re-assess the role of quality in water resources development and to elevate it to a position of comparable importance with water quantity. Water quality data is now considered necessary for water resources planning and management.

The presence of oxygen in water is a positive sign of a healthy body of water but the absence of oxygen is a signal of severe pollution. Most aquatic plants and animals need oxygen to survive. Fish and some aquatic insects have gills to extract oxygen from the water. Waters of consistently high dissolved oxygen are usually considered healthy and stable ecosystems capable of supporting many different kinds of aquatic organisms. Much of the dissolved oxygen in water comes from the atmosphere. Algae and rooted aquatic plants also deliver oxygen to water through photosynthesis. Large fluctuations in dissolved oxygen are characteristic of bodies of water with extensive plant growth. Depletion in dissolved oxygen can cause major shifts in kinds of aquatic organisms found in water bodies. Species that cannot tolerate low levels of dissolved

oxygen will be replaced by pollution tolerant organisms, such as worms and fly larvae. Nuisance algae and anaerobic organisms (that live without oxygen) may also become abundant in waters with low levels of dissolved oxygen.

STUDY AREA

The present study was carried out for Mansar (J&K) and Renuka (H.P.) Lakes located in the Western Himalayan Region. A map showing location of these lakes is shown in Fig. 1. Mansar and Renuka lakes are located in rural areas which may be classified under the category of rural lakes. Apart from fulfilling regular water needs, both these lakes are very important to local public for their religious significance and tourism activities. The physiographic details are given Table 1.

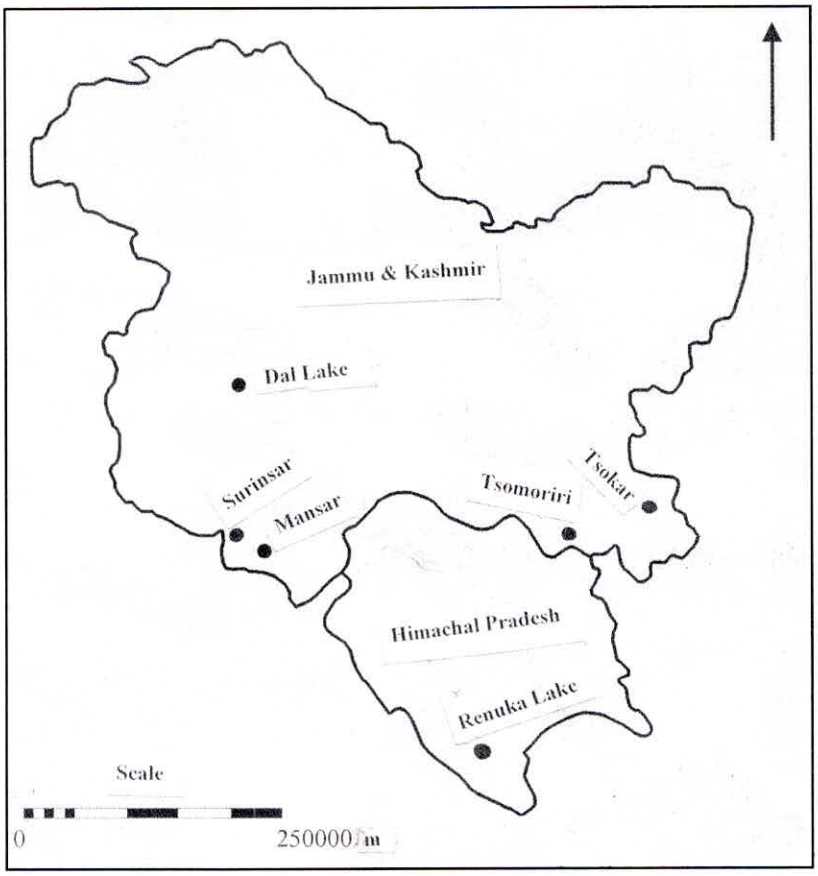

Fig. 1: Location Map of some Lakes in J&K and H.P.

Table 1: The physiographic details of the lakes

S. No.	Details	Lakes	
		Mansar	Renuka
1	District	Udhampur	Sirmaur
2	Type of lake	Rural	Rural
3	Latitude	32^0 40' 58.25" N	30^0 36' N
4	Longitude	75^0 5' 11.5" E	77^0 27' E
5	Altitude (m)	666	
6	Max. depth (m)	38.25	13
7	Area (Sq. Km)	0.59	0.18

METHODOLOGY

In the present study, water quality data pertaining to DO, BOD and Temperature of the Mansar and Renuka lakes was generated under NIH funded internal studies for water quality monitoring programs. Appropriate preservatives were added to fix the DO in the field as per standard procedures. The analysis was carried out using standards methods (APHA, 1985). The depth wise water samples were collected using Standard Water Sampler. The suitability of water for domestic purposes or fishery was made based on BIS (1991).

RESULTS AND DISCUSSION

Thermal Variation

Temperature variation in lakes is most important phenomenon, which essentially affect the kinetics of biochemical reactions and solubility of different gases in the water at different depths. In general, the heat transfer at the water surface tends to raise its temperature during summer and lower during winter. Therefore, the temperature difference at the top and bottom develops stratification of lakes/reservoirs during summer into three distinct zones consisting of upper, middle and bottom layers, which are called as epilimnion, thermocline or metalimnion, hypolimnion. However, during winter when the top layers become cooler in comparison of deeper, the sinking process starts which has greater mixing effect. Thus, the lake of medium depth undergoes complete mixing process and remains well mixed during winters.

In this study, the depth-wise thermal variation of the Mansar lake was studied during 1998-99 and 2004-05. The results are presented in Figs. 2a to 2f, which clearly show seasonal as well as depth-wise variation of temperature regime of the Mansar and Renuka lakes. In Mansar lake, surface water temperature varied from 14.2°C in winter (January) to 32°C in the summer (June/July). Rai et al. (2001) have reported

decrease in depth-wise water temperature from April to November in the Mansar lake. In this study, a temperature difference of about 18°C has been monitored from summer to winter months in the lake at surface. Temperature difference during stratification period was about 16°C from surface to bottom. It is reported that, for a difference of 10 °C temperature between two depths in the water columns, the density difference would be 0.0018 (Bhar, 1995-96).

The stable stratification persists during summer and monsoon months, which finally tends to become unstable during early winter (November and December), mainly due to falling of air temperature resulting in net heat loss from the lake. Both lakes become mixed during winter as evident from the Figures 2a-2f. Uniform temperature conditions from surface to bottom in lake water during January/February results vertical mixing causing a negligible difference in the temperature of surface and bottom layers of the lakes. These lakes undergoes two distinct stages namely complete mixed stage (during winter) and a stratified stage (during summer) and may be classified as warm monomictic type of the lakes.

VARIATION OF DO & BOD IN LAKES

A quarterly variation of DO in the Mansar lake has been shown in Figs. 3a to 4b for the months of January, June, September and December, respectively. It is evident that DO profiles of the Mansar lake nearly mimic the trend of thermal profiles under the same periods. Further, stratification of the lake during summer and mixing condition

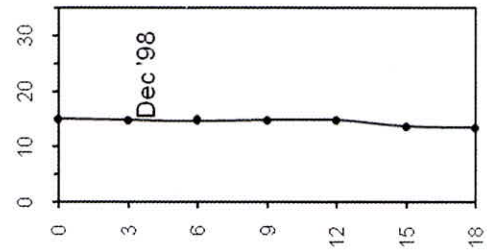

Fig. 2a: Temp. Variation of Mansar (Dec.)

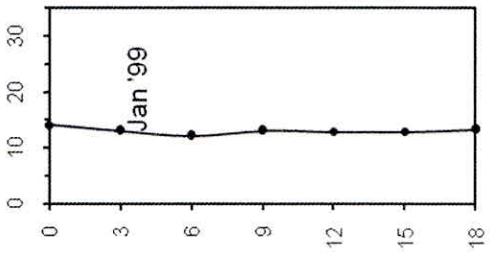

Fig. 2b: Temp. Variation of Mansar (Jan.)

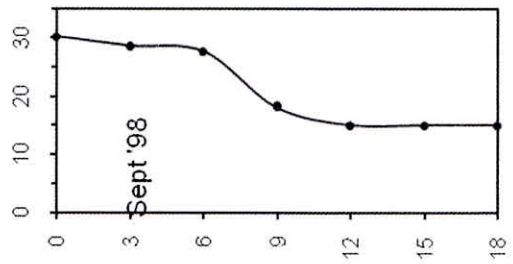

Fig. 2c: Temp. Variation of Mansar (Sep.)

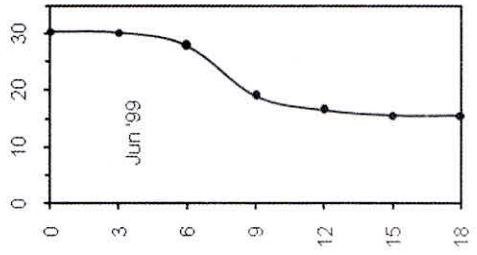

Fig. 2d: Temp. Variation of Mansar (June)

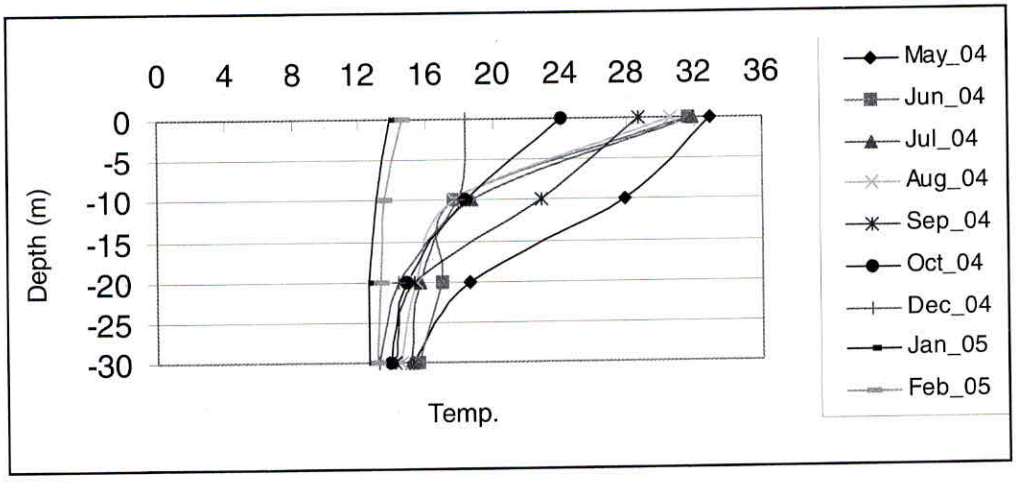

Fig. 2e : Depthwise Thermal Variation in Mansar Lake

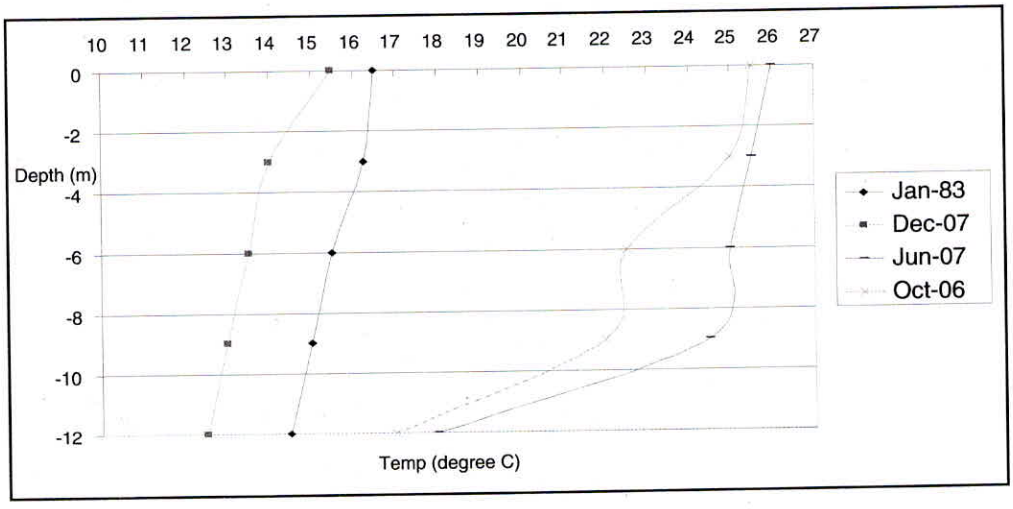

Fig. 2f : Depthwise Thermal Variation in Renuka Lake

during winter months is clearly visible. During winter months DO was found in the order of approaching 1.0, which could be problematic for survival of fish.

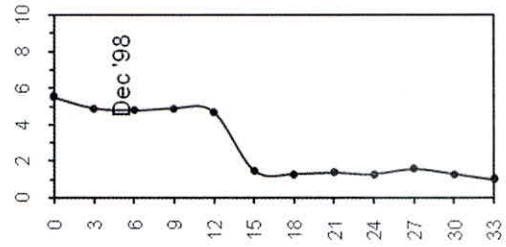

Fig. 3a: DO Variation of Mansar (Dec.)

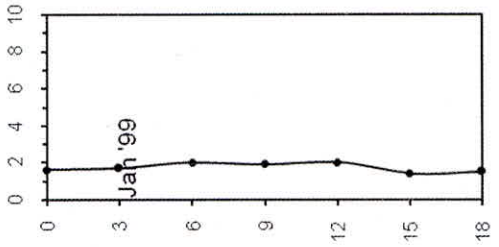

Fig. 3b: DO Variation of Mansar (Jan.)

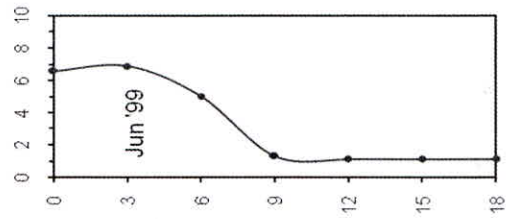

Fig. 3c: DO Variation of Mansar (June.)

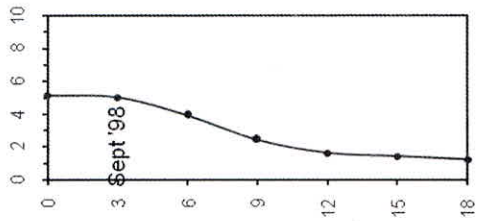

Fig. 3d: DO Variation of Mansar(Sep.)

In addition, the investigations carried out during 2004 also show that DO in epilimnion zone in the Mansar lake is below limit (6.0 mg/l; BIS, 1991) required for drinking purposes under Class-A (Table 2). Further, in hypolimnion zone mean values of DO are in the order of 0.45 mg/l to 1 mg/l against 4 mg/l required for survival of fishes, which indicate anoxia condition of the lake. This severe oxygen depletion associated with mixing of lakes from top to bottom may result mortality of fish.

Table 2: Variation of water quality Parameters in the Mansar Lake

Parameters	BIS Limits (1991)	May, 2004		September, 2004	
		Surface	Bottom	Surface	Bottom
DO (min)	6 , mg/l	3.3-6.6 (5.5)	0.3-0.6 (0.45)	3.4-7.4 (5.1)	0.5-1.7 (1.08)
BOD (max)	2, mg/l	1.2-6 (2.08)	1.2-14 (7)	2.4-6 (4)	5-8 (6.2)

The DO and BOD of the Renuka lake is given in Table 3, which indicates variation of DO from 0 to 10 mg/l from surface to bottom, respectively. The BOD was found 1 to 4 mg/l in the Renula lake.

CONCLUSIONS

The present study was conducted for the Mansar and Renuka lakes located in

Table 3 : Statistics of DO and BOD in Renuka Lake

Statistics	DO	BOD
N of cases	19	19
Minimum	0	1
Maximum	10	4
Median	8.8	2
Mean	7.61	2.09
Standard Dev	2.91	0.62
Variance	8.50	0.38
C.V.	0.38	0.29

the Western Himalayan Region. The study has shown that both these lakes remain stratified during summer and mixed during peak winter. These lakes have one mixing period in winter during a year. Accordingly, these lakes could be classified under monomictic type of lakes.

DO and BOD values indicated that bottom layers of these lakes remain mostly under anoxious condition (DO < 6.0 mg/l) throughout the year. However, during peak winter both lakes face overturning of top water with bottom water causing mixing of lake. Low temperature from top to bottom coupled with DO below 4.0 mg/l, may also be a reason for frequent fish mortality in these lakes reported during winter months.

In view of DO frequent deficit, suitable artificial measures are required to keep adequate DO levels for maintaining ecological balance in the system.

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