International Symposium on
Hydrology of Mountainous Areas
Shimla (INDIA) May 28-30, 1992

Study of Chemical Characteristics of the Water of Naukuchia Tal - A Central Himalayan Lake

Kireet Kumar, D.S. Rawat and Ranjan Joshi
G.B.Pant Institute of Himalayan Environment and Development
Kosi-Almora (U.P.) INDIA

ABSTRACT

Lakes are the potential source of fresh water at high altitude areas of Himalayan region. Rapid growth of human activities in the catchment areas of these water bodies are responsible for deterioration of its water quality. This study was conducted in Naukuchiatal, a lake located in the Himalayan region of Uttar Pradesh at an altitude of about 1300m above mean sea level. Chemical parameters such as dissolved oxygen (DO), total dissolved solids (TDS), total hardness, chlorides and sulphates were tested in the lake water during critical winter season. Oxygen (dissolved) level was found quite low at both the boat parking due to organic pollution contributed by human activities. The study indicated that DO was the most critical parameter for assessment of lake water quality. Other characteristics were found within the the acceptable limits when compared with Class-B of irrigation water quality. Suggestions are made for putting certain restrictions on human activities at both the boat parking to reduce the pollution load on the lake.

KEY WORDS

Physico-chemical parameters, Dissolved Oxygen, Irrigation, Human activities.

STUDY OF CHEMICAL CHARACTERISTICS OF THE WATER OF NAUKUCHIA TAL - A CENTRAL HIMALAYAN LAKE

INTRODUCTION

Northern part of the country has three main Himalayan rivers which are contributing to the greater share of freshwater for domestic and irrigation purposes in the plains of their regime. These rivers are hardly serving any purpose as far as domestic water supply and irrigation of high altitude areas of Himayalan region is concerned. Therfore, in these areas lakes and natural springs remain the only potential source of freshwater and hence this study is of great importance. Rapid growth of human activities in the catchment areas of the lakes has been a proven threat for the very existence of lakes located in lesser Himalaya, due to excessive silting (Khanka & Jalal, 1985). The quality of water is also affected by the human activities to a great extent. The present study is focused on qualitative aspect of Naukuchiatal which is one of the largest lakes of Kumaun Himalaya, located in ($29^0$32'N and $72^0$21'E) at an altitude of 1320m above MSL in Nainital district of Uttar Pradesh (Atkinson, 1989).The maximum aerial extent of this lake is about 90 ha with an average depth of 21.90 m (Rawat, 1988). The water of Naukuchiatal is managed by Irrigation department of Uttar Pradesh and excess water from this lake is used for irrigation and drinking purposes in lower valley villages.The study of water quality of this lake was thought to be of great importance for future planning of the water resources. In addition, Naukuchia tal is a tourist place and clear water of the lake is the main attraction for tourists. This study also has a component of assessing the impacts of tourism on lake water.

METHOD

In this study, physico-chemical parameters in lake water were monitored for obtaining water quality profile along the lake boundary. The parameters such as Total Dissolved solids and Dissolved Oxygen were analysed by taking grab samples in the field at N_1 to N_6 (Fig. 1.0) with the help of water testing kit. Composite samples were collected from three stations (Fig. 2.0)at an interval of 4 hours for two days, along the length of the lake and samples were analysed in the laboratory for total hardness, chlorides & Sulphates as per standard methods (APHA, 1987). The results are presented in in Fig. 1.0 and Fig. 2.0. Sampling locations are also shown in those figures.

RESULTS AND DISCUSSIONS

Naukuchia lake can still be categorized more towards the *oligotrophic* class considering its physiography and possible nutrient levels in its water (as classified by Dasmann,1984). However, due to leaching out of nutrients from agricultural

fields and increasing human activities it is grdually changing to *Eutrophic* lake which contains high nutrients level to support life systems. At the time of the study it was found that the lake water was free from submergent or floating aquatic vegetation. Presence of fish fauna in deep waters supported by some submerged vegetation makes it a moderately fertile lake. Under the conditions, it is obvious that the lake water should be of the highest quality for irrigation. But it was observed that increasing human activities in its catchment has changed this ideology.

Present study was conducted during winter season to assess the physico-chemical characteristics of the surface water along the boundary line and in the center of the lake. The Winters are considered as the lean tourist season in that area during which tourist activities are at the minimum and the activities of local population are only confined to its catchment area. This study gave an idea of variations in lake water quality around its periphery. At stations N_2 and N_5 (at the boat parks) the local human interference was observed even during winter season. Remaining sampling stations are not approachable by road and hence, expected to be least affected by human activities.

The amount of Dissolved Oxygen (DO) is one of the most important chemical parameters in water systems. In lake water, surface currents generated due to wind are responsible for DO uptake by mixing but at a slower rate than in rivers.Cold water holds more oxygen in dissolved form than warm water and the saturation level of oxygen at study temperature is 11.08 mg/l.The study in Naukuchia tal showed the high initial DO level of 9.90 mg/l at station N_1. (Fig. 1.0). It is evident that DO values are in decreasing order and oxygen deficit is quite clear. The Minimum value of oxygen (4.35 mg/l) was recorded at the lower boat parking which was due to high organic loading. This part of the lake is critical with regard to DO levels as it is the outlet of irrigation water. Further decline in oxygen level below 4 mg/l is very likely in summer due to more human activities at that time.This may harm the aquatic life present in the lake. Decrease in the oxygen deficit beyond N_2 is mainly due to less inflow of organic load and self purification, taking place at a slow rate in the lake water.

The oxygen level increased to 5.30 mg/l at N_4 but again a decline in DO was observed due to another boat parking on upper side of lake. The obvious reasons were organic pollution due to human activities in that area. The DO profile of the lake water with increasing DO deficit from 1.18 mg/l to 6.65 mg/l, clearly indicates adverse impacts of the human activities on Dissolved oxygen level even during the

lean tourist season. It can be concluded that the lake has a low carrying capacity as far as organic load is concerned and uncontrolled human activities in the lake can render its water unfit for irrigation. The self purification capacity of the lake is also quite low and hence, the water quality monitoring is necessary during all seasons to check the required DO levels for aquatic life as well as for irrigation water.

For the study of total hardness water samples were collected from upstream, downstream and center of the lake. The values observed are of the order of 56 to 60 mg/l. Maximum value of 60 mg/l was obtained at lower boat parking. However, variations in total hardness values were not significant.

Concentration of chloride and sulphate compounds are important parameters for the studying the quality of water. Hence, these parameters were also monitored in three locations as in the case of total hardness. It was observed that the chlorides concentrations in lake water were quite low with a maximum value of 10.64 mg/l observed at lower boat parking. Sulphate concentrations of 5.00 mg/l was observed at that point. There is a significant variation in sulphate concentration (Fig. 2.0). However, these values are within the admissible limits of irrigation water. General trends of all the chemical parameters in lake water reveal increasing concentration towards the lower boat parking which indicate impacts of human activities at that point.

The levels of total dissolved solids (TDS) in lake water were also monitored during the study considering the possible salinity problems associated with high TDS values. Fig. 2.0 gives an idea of TDS variations along the lake. In this figure, the values of the order of 350 mg/l to 540 mg/l were observed in the lake water. As per the categories of water quality for irrigation purpose (Jermar, 1987), the TDS levels are well below the limit of 800 mg/l for the best class of water . The dissolved matters in lake water were expected due to the presence of soluble minerals in the limestone and sandstone rocks surrounding the lake, the alkaline nature of lake water with pH ranging from 8.5 to 9.5 also confirms this fact.

CONCLUSIONS

From the present study, the following conclusions can be drawn.

1. The pollution in the lake water is largely due to human activities near the boat parking. The decrease in dissolved oxygen level to a minimum value of 4.35 mg/l

at the lower boat parking is due to heavy organic loading. The DO uptake of 10 percent as observed at a stretch of 200 m along the lake boundary, is mainly due to low pollution load.

2. DO profile indicates lower and upper boat parking as the two critical locations within the lake boundary where human activities should be restricted during the tourist seasons to prevent further DO depletion. The carrying capacity of the lake with respect to organic load is quite low at these locations. Therefore alternate boat parking should be built along the lake boundary considering its carrying capacity during all seasons.

3. Dissolved solids, Chlorides and Sulphates are present in lake water. But the concentrations of all these parameters were found well below the levels prescribed for irrigation water.

4. Total calcium and Magnesium hardness which is imparted by sandstone and limestone rocks of that area, was present in all the samples. But the water can still be considered good for irrigation at that level of Hardness.

5. The dissolved oxygen was found to be the most decisive factor for the categorization of the quality of Naukuchia tal water.DO saturation level of the order of 50% to 90% in most of the water samples indicates that the water falls under "Class- B" category of irrigation water.

ACKNOWLEDGEMENTS

The authors are thankful to the Director of the Institute for his support and guidance during this study.

REFERENCES

1. APHA, (1989), 'Standard methods for the examination of water and wastewater', Seventeenth Ed., Washington, DC.

2. Atkinson, E.T., (1989), 'Geology of the Himalayan', Cosmo Publications, New Delhi, India, pp. 199-200.

3. Dasmann, R.F., (1984), 'Environmental conservation', John Willy & Sons, New York, pp. 262-264.

4. Jermar, M.K., (1987), 'Water resources and water management', Elsevier Science Publishers, Amsterdam, The Netherlands, pp. 169-207.

5. Khanka, L.S. and Jalal, D.S., (1985), 'Physico-limnological analysis of Naukuchia tal-lake, Kumaun Himalaya, Him. Rev. & Dev., 4 (2), pp. 51-54. [cited from Rawat, (1988).]

6. Rawat, J.S., (1988), 'Water resources and burning hydrological problems of Kumaun', In: K.S.Valdia(Ed.), "Kumaun Land and People", Gyanodaya Prakashan, Nainital, India, pp. 201-212.

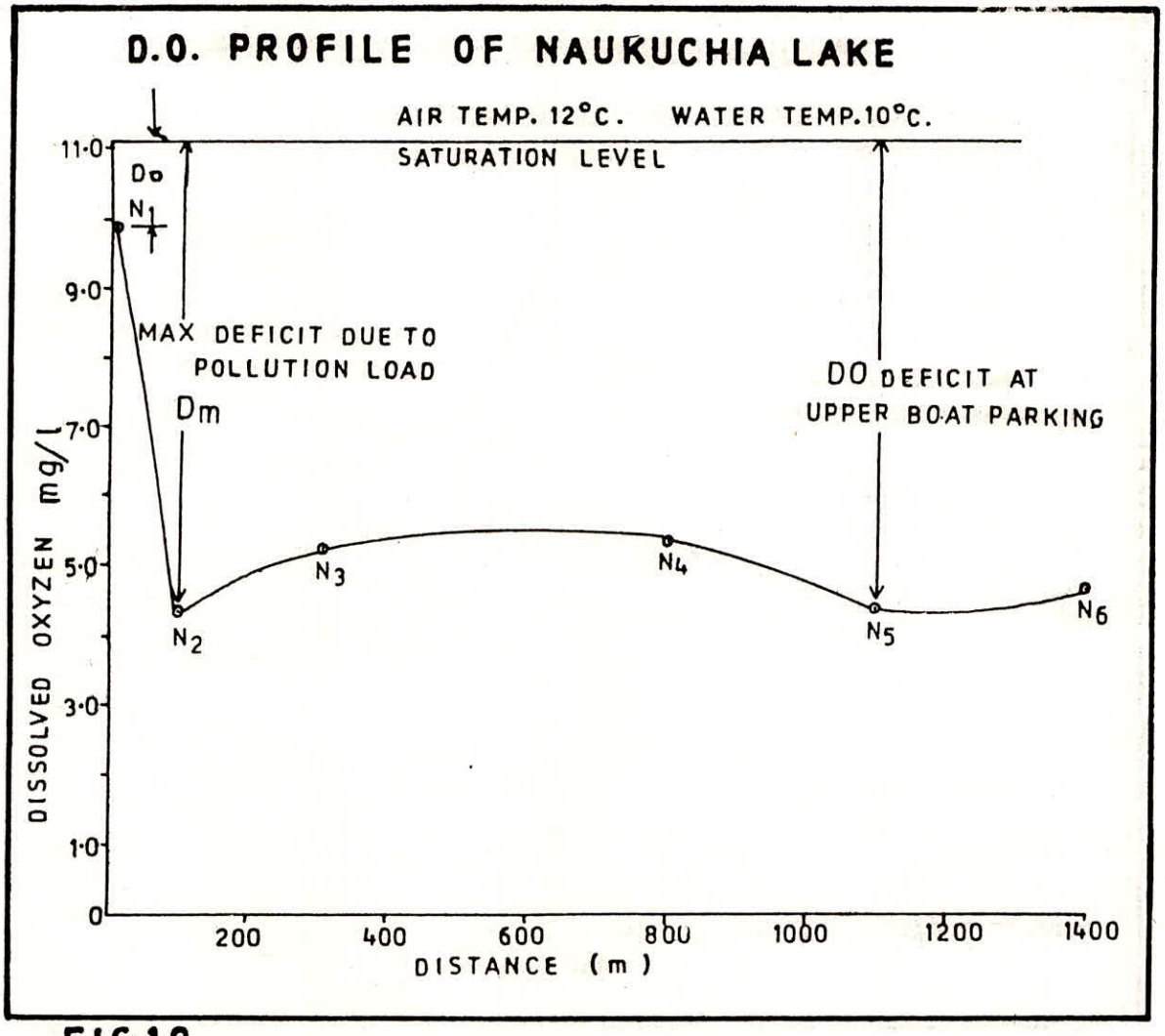
D.O. PROFILE OF NAUKUCHIA LAKE
AIR TEMP. 12°C. WATER TEMP. 10°C.
SATURATION LEVEL
Do
N1
MAX DEFICIT DUE TO POLLUTION LOAD
Dm
DO DEFICIT AT UPPER BOAT PARKING
N2
N3
N4
N5
N6
DISSOLVED OXYZEN mg/l
11·0
9·0
7·0
5·0
3·0
1·0
0
200
400
600
800
1000
1200
1400
DISTANCE (m)

FIG.1·0.

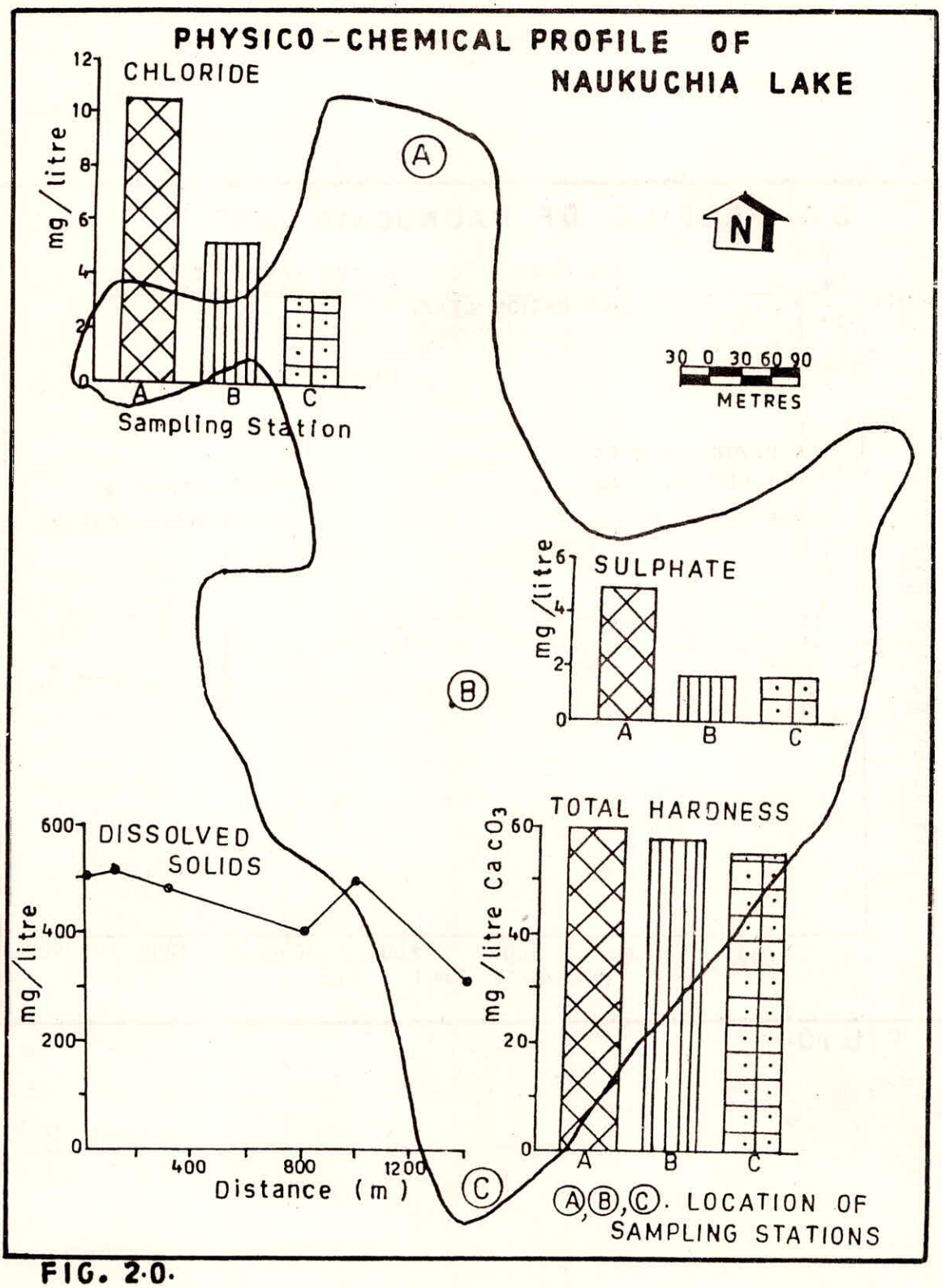
PHYSICO-CHEMICAL PROFILE OF
NAUKUCHIA LAKE
CHLORIDE
mg/litre
12
10
8
6
4
2
0
A
B
C
Sampling Station
A
N
30 0 30 60 90
METRES
B
SULPHATE
mg/litre
6
4
2
0
A
B
C
DISSOLVED
SOLIDS
mg/litre
600
400
200
0
400
800
1200
Distance (m)
TOTAL HARDNESS
mg/litre Ca CO3
60
40
20
0
A
B
C
C
A, B, C. LOCATION OF
SAMPLING STATIONS

FIG. 2.0.