

Changes in Physico-chemical Characteristics of a Warm Monomictic Lake over a Period of Two and a Half Decade

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ABSTRACT

Present paper detects the change in various physicochemical characteristics of a warm monomictic Manasbal lake over a period of more than two decades. Vertical variation in the physico-chemical parameters in an off shore region of the lake was analyzed during a three months period of stratification and was compared with the previous observations made by Wanganeo (1980). A significant change in various parameters has been observed. Bottom waters were anoxic during the month of June in comparison to the values obtained by Wanganeo during June, 1980. Specific conductivity, Ammonical nitrogen, phosphate phosphorous and nitrate nitrogen etc. also showed enhancement in its values over a period of more than two decades.

Key words: Physico-chemical characteristics, temporal variation, warm monomictic lake.

INTRODUCTION

Present investigation was conducted on Manasbal lake (34° 15' N and 74°40' E) during a brief period of three months from April to June. This oxbow type, warm monomictic lake is situated at an altitude of 1583m. a.s.l., about 32 Kilometers away towards North west of Srinagar city (the summer capital of Jammu and Kashmir State). Manasbal lake is having a maximum length and breadth of 3.5 and 1.5 km respectively. The lake covers an area of 2.81 km² and its volume and maximum depth are 0.0128 km³ and 13m respectively (Wanganeo 1980). The observations made during the present study period (i.e. from April to June, 2005) clearly demonstrate that the thermal stratification predominantly affects the vertical distribution of various chemical features in this warm monomictic lake (Manasbal).

MATERIAL AND MEHODS

The methods employed for analysis of various physico chemical characteristics of water were after APHA (1995). For the purpose of physico-chemical analysis of water, sampling was done in the pelagic zone at a site of maximum depth (Fig.1). A fortnightly schedule has been followed for sampling purpose.

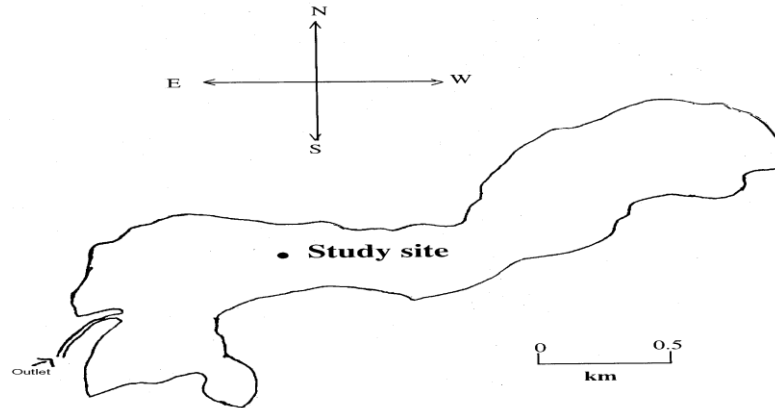


Fig. 1. - Outline Sketch of the Manasbal lake showing the study site.

RESULTS AND DISCUSSION

Air and surface water temperature showed a close relation however, during the year 1979 (Wanganeo, 1980) air temperature was more in comparison to the year 2005 (Fig.2a,b,c). Column variation in water temperature has been presented in Fig.2a, b. During both the years the lake was thermally stratified. Wanganeo (1980) categorized this water body among warm monomictic lakes.

As reported by Wanganeo (1980), water temperature in the month of April was found to be uniform upto a depth of 3.5 m which in the month of June extended upto 4.5 m (Table 1 and Fig.2a,b), below that it fell sharply till 7.5m depth. On the other hand during present study, uniformity in water temperature was found vertically extending upto a depth of 3.5 m. Thereafter, water temperature recorded a uniform pattern throughout the study period.

The Secchi transparency values observed by Wanganeo (1980) fluctuated from 3.75m (April) to 4.75m (May) while as, during present investigation the mean minimum transparency values varied from 4.25m (June) to 4.67 m (April). The change observed in Secchi transparency is on account of the variation in climatic condition besides the cloud cover (Fig.2d).

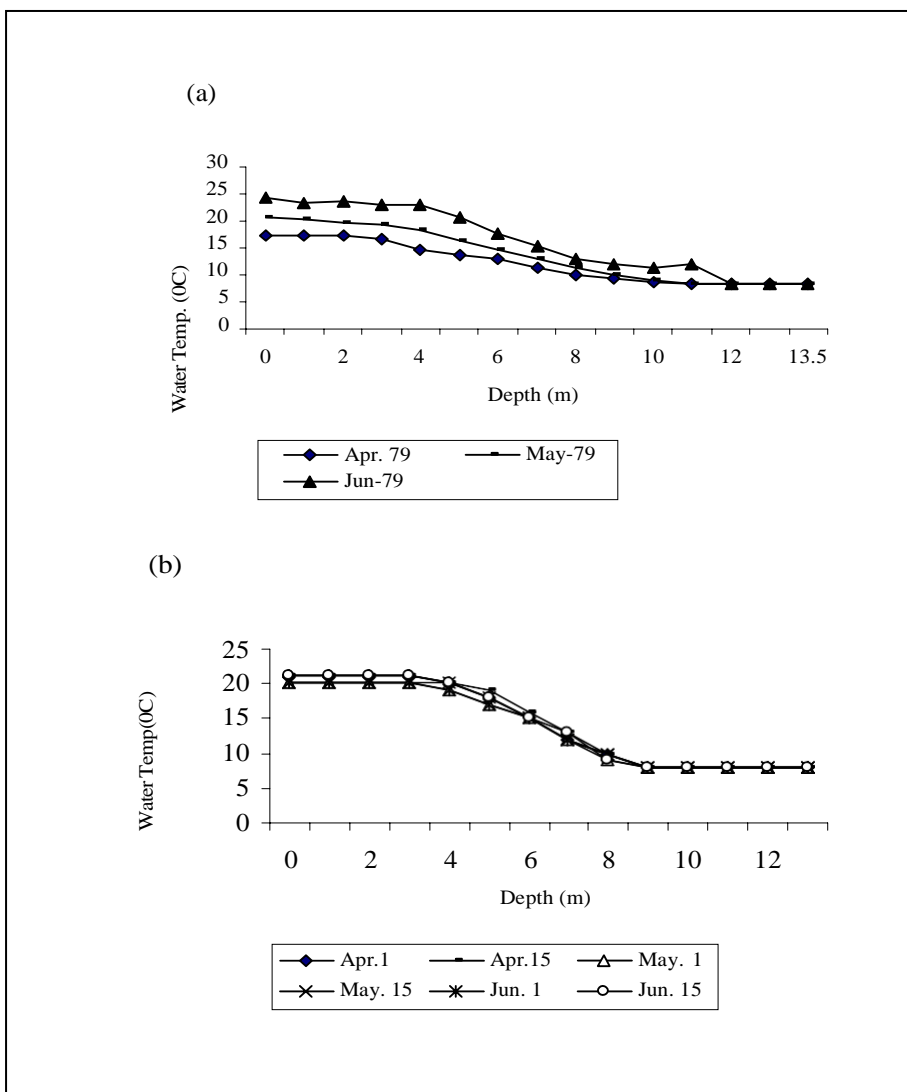


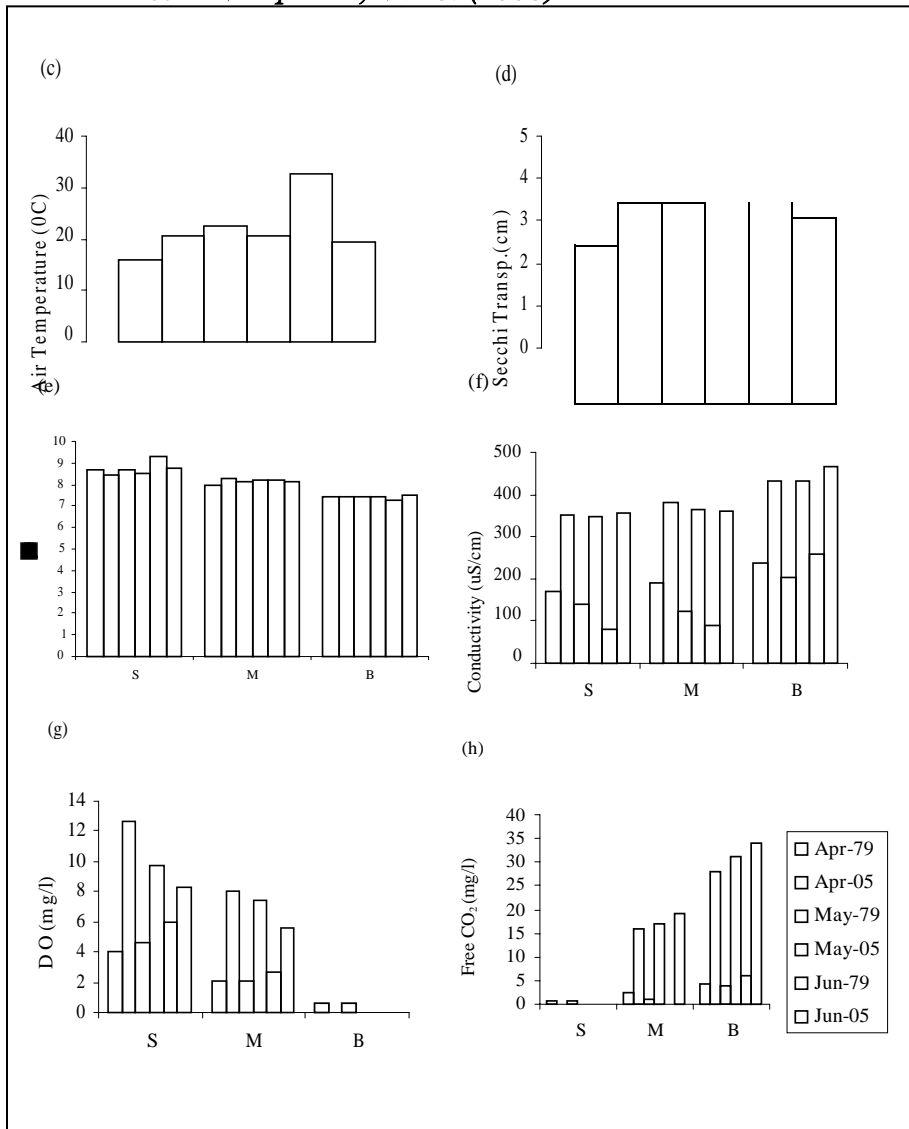
Figure 2a,b. Vertical thermal profiles, from Apr. to June, during 1979 (Wanganeo, 1980) and during 2005 in Manasbal lake.

The pH in surface, mid and bottom waters during previous observation (Wanganeo, 1980) varied from 8.7 units (April) to 9.3 units (June), 8 units (April) to 8.2 units (June) and 7.30 units (June) to 7.39 units (April and May) respectively (Wanganeo, 1980), while as during present study the monthly mean values of pH fluctuated from 8.4 units (April) to 8.7 units (June) and 8.1 units (June) to 8.2 units (April) in the surface and mid water respectively. No prominent variation in the mean values for pH was observed from April to June in case of bottom samples.

The comparative study reveals that conductivity values as recorded by Wanganeo (1980) varied from 80 $\mu\text{S}/\text{cm}$ (June) to 168 $\mu\text{S}/\text{cm}$ (April), 87.5 $\mu\text{S}/\text{cm}$ (June) to 191 $\mu\text{S}/\text{cm}$ (April) and 202.5 $\mu\text{S}/\text{cm}$ (May) to 260 $\mu\text{S}/\text{cm}$ (June) in surface, mid and bottom waters respectively. However, during present study the mean Conductivity values in surface and mid waters ranged from 347 $\mu\text{S}/\text{cm}$ (May) 357.6 $\mu\text{S}/\text{cm}$ (June) and 361 $\mu\text{S}/\text{cm}$ (June) to 383 $\mu\text{S}/\text{cm}$ (April) respectively, while as in bottom waters it varied from 430.5 $\mu\text{S}/\text{cm}$ (April) to 466.5 $\mu\text{S}/\text{cm}$ (June). Increase in the conductivity values with depth is on account of increase in the concentration of dissolved substances in the deeper waters. Kulshrestha *et al.*'s (1989) findings also support such contention.

Early observation (Wanganeo, 1980) revealed that DO concentration in surface and mid waters varied from 4 mg/l (April) to 5.94 mg/l (June) 2.04 mg/l (May) to 2.64 mg/l (June), respectively (Fig.2g), while as, during present work the monthly mean value of DO content (Table 1 and Fig.2g) in surface and column waters ranged from 8.3 mg/l (June) to 12.7 mg/l (April) and 5.6 mg/l (June) to 8 mg/l (April). DO content of bottom waters during previous work (Wanganeo 1980) varied from below detection level (June) to 0.66 mg/l (April). However, it remained below detection level throughout the present investigation period. As revealed in the previous work (Wanganeo 1980) free CO_2 in surface, mid and bottom waters fluctuated from below detection level (June) to 0.66 mg/l (April and May), below detection level to 2.44 mg/l (April) and 3.96 mg/l (May) to 5.94 mg/l (June) respectively (Fig.2h). However, during present work free CO_2 in surface waters was found absent. The mean CO_2 concentration varied from 16 mg/l (April) to 19 mg/l (June) in column water and from 28 mg/l (April) to 34 mg/l (June) in bottom water (Fig.2h). Wanganeo and Wanganeo (1994) further reported that the hypolimnetic anoxia and clinograde type of oxygen profiles support the contention that the lake is undergoing accelerated eutrophication.

Phenolphthalein alkalinity remained absent during both the study periods except in the surface waters (Fig.3a). Total alkalinity in the surface waters during 1979 (Wanganeo, 1980) and present work ranged from 75.25 mg/l (May) to 122 mg/l (April) and 126 mg/l (June) to 135 mg/l (April) respectively while in mid and bottom waters it fluctuated from 91 mg/l (May) to 122 mg/l (April) and 130 mg/l (April) to 168 mg/l (June) respectively during 1979 (Wanganeo, 1980) and from 138 mg/l (June) to 146 mg/l (May) and 172 mg/l (April) to 178 mg/l (June) respectively during present work (Fig. 3b).



Where: S, M and D represent the surface, mid (Z=6m) and bottom (Z=12m) waters respectively.

Figure 2 c-h. Variation in some Physico-chemical parameters in Manasbal lake

The values of total hardness in surface waters during 1979 (Wanganeo, 1980) and present investigation periods ranged between 24 mg/l (May) to 46 mg/l (June) and 136 mg/l (June) to 177 mg/l (April) respectively. In mid waters, during 1979 (Wanganeo, 1980) and present work it fluctuated from 28

mg/l (May) to 67 mg/l (June) and 162 mg/l (June) to 177 mg/l (April) respectively. Total hardness in the bottom waters during 1979 (Wanganeo, 1980) and present investigation ranged from 33 mg/l (May) to 55 mg/l (June) and from 258 mg/l (June) to 276 mg/l (April) respectively (Fig. 3c).

The values of calcium hardness in surface, mid and bottom waters during 1979 (Wanganeo, 1980) varied from 12 mg/l (May) to 14 mg/l (April), 9 mg/l (April) to 18 (June) and 9.4 mg/l (April) to 21 mg/l (May) respectively. During present investigation the minimum and maximum mean values for this parameter in surface, mid and bottom waters were 114.4 mg/l (June) and 155.3 mg/l (April); 132 mg/l (June) and 138.6 mg/l (May) and 207.9 mg/l (May) and 216.3 mg/l (June) respectively (Fig.3d).

Magnesium hardness of surface, mid and bottom waters during 1979 (Wanganeo, 1980) varied from 3 mg/l (May) to 8 mg/l (June), 3 mg/l (May) to 12 mg/l (June) and 3 mg/l (May) to 11 mg/l (April and June) respectively. During present work the mean values of magnesium hardness ranged between 21.7 mg/l (May) and 23.7 mg/l (April) in surface water, while in mid and bottom waters these ranged from 38 mg/l (June) to 42.6 mg/l (April) and 47.9 mg/l (June) to 66 mg/l (April) respectively (Fig.3e).

As observed by Wanganeo (1979) the chloride content in surface, mid and bottom waters varied from 13.5 (April) 19.5 (June) 7.84 mg/l (May) to 20.42 mg/l (Mg/l) and 8.3 mg/l (April) to 16.5 mg/l (June) respectively. On the other hand during present work chloride concentration of water fluctuated within a narrow range of 12 mg/l to 14 mg/l only (Fig. 3f).

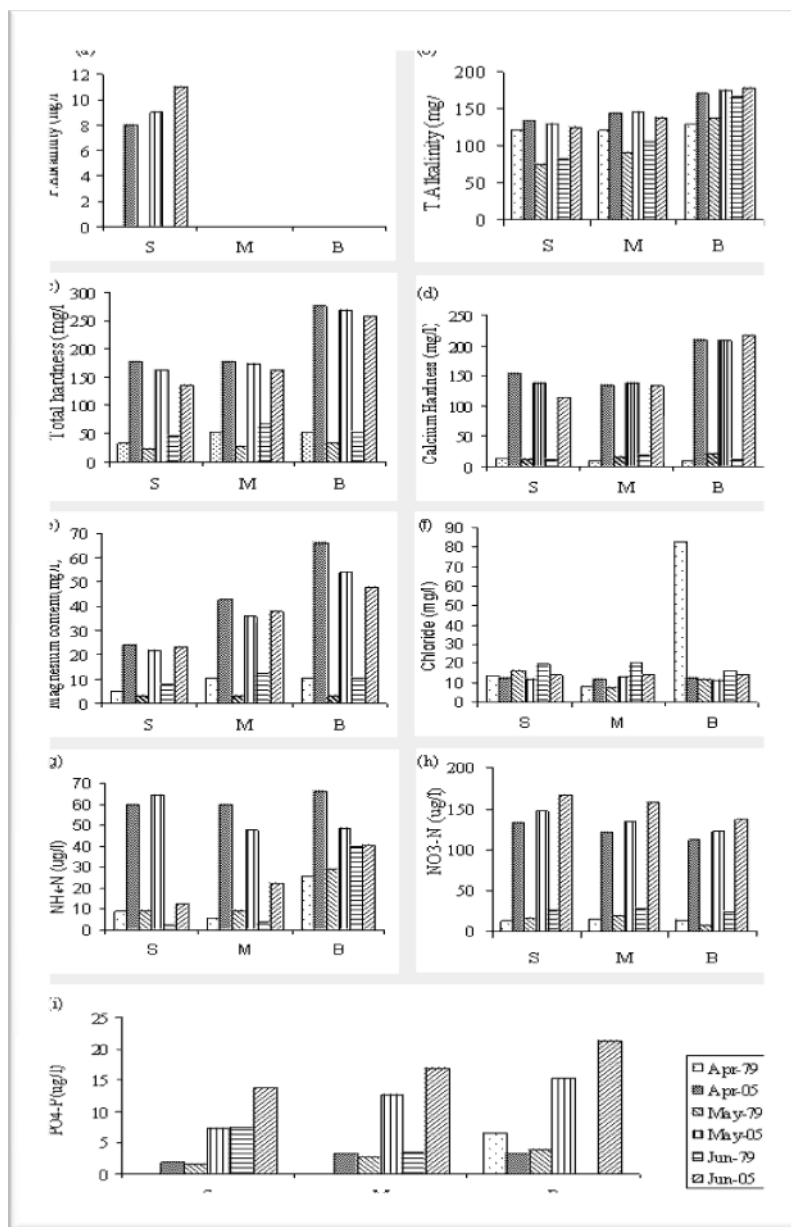
Ammonical nitrogen concentration in the surface, mid and bottom waters varied from 1.87 $\mu\text{g/l}$ (June) to 9.37 $\mu\text{g/l}$ (May), 3.62 $\mu\text{g/l}$ (June) to 9.05 $\mu\text{g/l}$ (May) and 25.34 $\mu\text{g/l}$ (April) to 39.82 $\mu\text{g/l}$ (June) during the year 1979 (Wanganeo, 1980). The monthly mean concentration of $\text{NH}_3\text{-N}$ in surface mid and bottom waters during present work, however, varied from 12.22 $\mu\text{g/l}$ (June) to 64.27 $\mu\text{g/l}$ (May), 22.49 $\mu\text{g/l}$ (June) to 59.83 $\mu\text{g/l}$ (April) and 40.58 $\mu\text{g/l}$ (June) to 66.36 $\mu\text{g/l}$ (April) respectively.

In an observation made by Wanganeo (1979) (Fig.3h) Nitrate nitrogen in surface, mid and bottom water, from April to May, fluctuated from 13.12 $\mu\text{g/l}$ (April) to 26.18 $\mu\text{g/l}$ (June), 16 $\mu\text{g/l}$ (April) to 28 $\mu\text{g/l}$ (June) and 8 $\mu\text{g/l}$ (May) to 24 $\mu\text{g/l}$ (June). On the other hand during present work (Fig.3h) the mean concentration of nitrate nitrogen in surface, mid and bottom waters ranged from 121.24 $\mu\text{g/l}$ (April) to 151.84 $\mu\text{g/l}$ (June) and 112.44 $\mu\text{g/l}$ (April) to 137.36 $\mu\text{g/l}$ (June) respectively. A significant increase in the concentration of $\text{NO}_3\text{-N}$ content of water seems to be on account of agricultural wastes and sewage contamination (Walmsley *et al.*, 1979).

The comparative study reveals that 2.7 decades ago (Fig.3i), the concentration of phosphate phosphorus ranged from below detection level (April) in surface and mid water to 7.5 $\mu\text{g/l}$ (June) and 3.45 $\mu\text{g/l}$ (June) respectively (Wanganeo, 1979). While as during present study (Fig.3i) the mean concentration of this inorganic form of phosphorus in surface, mid and bottom waters fluctuated from 1.84 $\mu\text{g/l}$ (April) 13.61 $\mu\text{g/l}$ (June); 3.17 $\mu\text{g/l}$ (April) to 16.97 $\mu\text{g/l}$ (June) and 3.2 $\mu\text{g/l}$ (April) 21.23 $\mu\text{g/l}$ (June) respectively.

The perusal of data reveals that a marked increase in PO₄-P concentration has occurred in the pelagic region of this thermally stratified lake since last two and half decades. Such an increase in reactive PO₄-P content may be on account of addition of detergents from the growing population besides release of additional phosphate from dead and decayed phytoplankton cells and concentration of zooplankton excreta (Gainey and Loard, 1952 and Heron, 1961). The other potential internal phosphorus sources to the lake include anaerobic sediments (Lijklema, 1994 and Garber and Hartman, 1985). Benthic invertebrates also mediate in the transfer of phosphorus from the sediments (Gardner *et al.*, 1981) while active phosphorus transport by macrophytes in the littoral zone has also been assessed by DeMarte and Hartmen (1974). Another reason for enhancement of nutrients in the lake water is low renewal rate (Zutshi and Wanganeo, 1989).

Based on the foregoing discussion a vivid enhancement in various parameters has been obtained on account of the infringement of the catchment area by way of anthropogenic activity. Since the water body is having surface outlet only, resulting in removal of surface waters only the cumulative impact in terms of anoxic hypolimnion can very well be understood in this unique warm monomictic Kashmir Himalayan water body. Present paper warns further infringement and suggests banning of all sorts of human activities detrimental for this pristine water body, a store house of biodiversity.



Where : S, M and D represent the surface, mid (Z=6m) and bottom (Z=12m) water respectively.

Figure 3a-i. Variation in some chemical parameters in Manasbal lake

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