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Effect of thermal stratification on various Physico-Chemical parameters of the Manasbal Lake

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ABSTRACT

Manasbal a monomictic fresh water lake of the Valley experiences thermal stratification from March to November . A study was conducted from January, 2012 – December ,2013 for different Physico Chemical parameters in the Lake .A marked depth wise variation in water temperature was recorded . A clinograde type of dissolved oxygen curve was recorded . It was minimum at the surface water, the bottom water became severely depleted during certain periods . pH values showed a decreasing trend from surface to bottom .The bottom water showed acidic pH values through out the study period while as during circulation period it showed a slight variation from surface to bottom . Alkalinity was mainly due to bicarbonates and showed a considerable increase in the content with increasing depth .Conductivity , Carbon dioxide values increased from surface to bottom . The lake is a typical "hard water". Both hardness and calcium showed variation from surface to bottom during stratification period .

Key words :- Clinograde , Depleted , Hard water , Monomictic , Thermal stratification

I.INTRODUCTION

Manasbal lake , is the deepest fresh water valley lake of Kashmir. It is situated at an altitude of 1585 m (a.s.l) within the geographical coordinates of North latitude 34°15′28″- 34°14′30″ and East longitude 74°39′10″ - 74°41′30″. The lake is oblong in out line, measuring 2.8 km^2 in area with maximum depth of 13m and is semi drainage type with only a well recognized out flow channel, called Nunniyor Nalla. Having no major tributary, its water supply is chiefly derived from internal springs and precipitation .

The lake has hamlets of Kondabal , Jarokabal and Gratabal over looking it. According to [1] it is a warm monomictic type lake . The lake has over the years been greatly influenced by the human activity in its immediate catchment and signs of eutrophication have been reported [2]. Present investigation was aimed to study the effect of thermal stratification on various physico chemical parameters of the lake and the objective of the study was which factors regulate depth wise variations of these parameters .

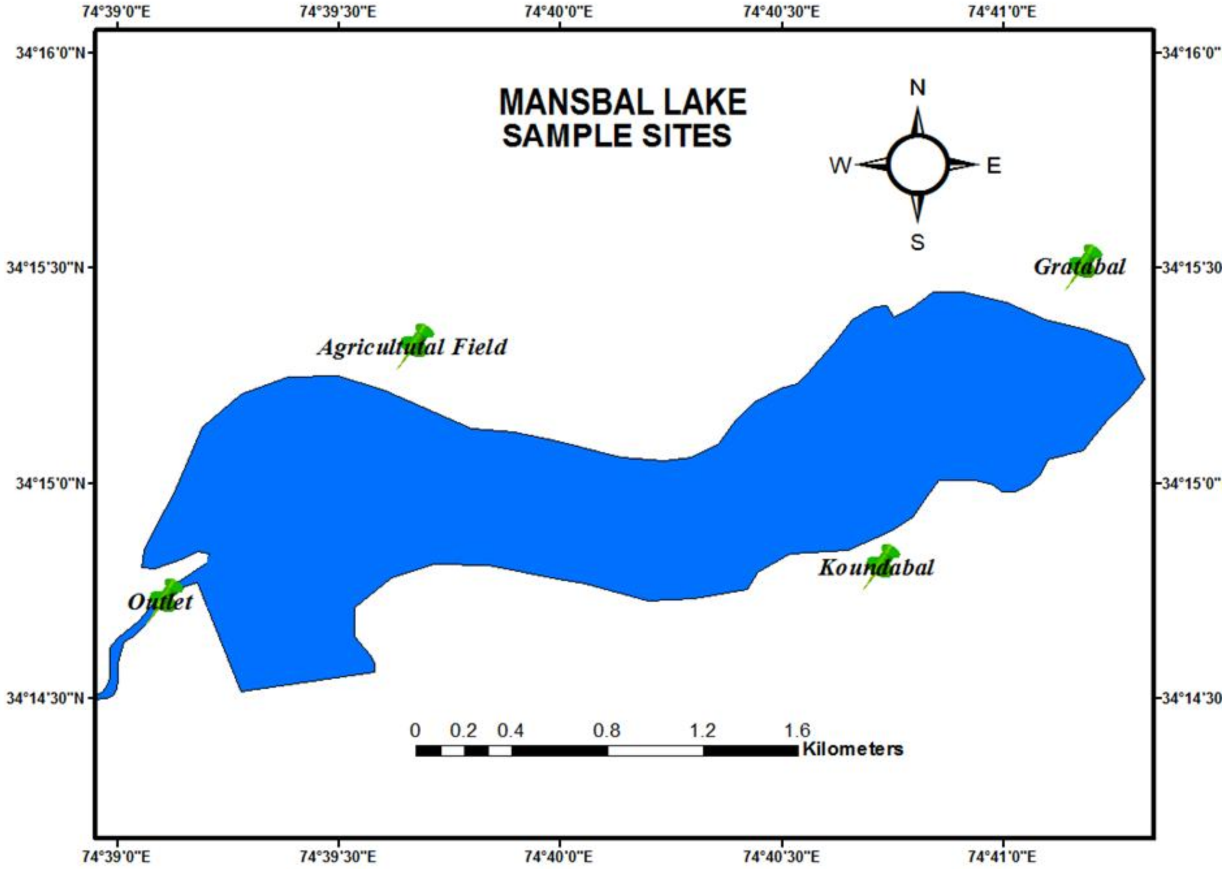

Fig :- Map of the Manasbal Lake

II. MATERIALS AND METHODS

For collection of water samples the lake was monitored between 9 a.m to 12 a.m . Temperature was measured by a graduated Celsius thermometer, transparency was estimated by standard Secchi disc , pH were measured with the help of portable pH meter (HANNA Model –PHEP) and conductivity with the help of portable conductivity meter (HANNA Model – DIST -3). Dissolved oxygen content was determined by Iodometric Azide Modification Method of Winkler [3], free carbon dioxide , alkalinity and hardness by titremetric method [4] .

III. RESULTS

1.1. TEMPERATURE

Atmospheric temperature ranged from 6.3ºC (January) to 33ºC (July) Fig 1. A characteristic depth wise variation in water temperature was recorded during different seasons. Water temperature ranged from 5.1ºC

(January) at 12 m depth to 30.5ºC (July) at the surface. During the circulation period from December to February, the entire water column had a uniform temperature with a little variation from surface to bottom. In stagnation period from March to November, surface water temperature remained high than deeper waters, a marked variations in water temperature was found from surface to bottom (Fig 2).

1.2. TRANSPARENCY

Water was clear and light penetration was observed up to the depth of 4.3m. It ranged from 2m (March) to 4.5m (July) . The Lower values were observed during autumn / winter and maximum during summer(Fig 3).

1.3. CONDUCTIVITY

Data pertaining to conductivity values ranged from 184 µS/cm (June) at surface to 365 µS/cm (September) at 12 m depth . Therefore conductivity values increased from surface to bottom. During circulation period from December to February conductivity from surface to 12 m depth showed very little variation(Fig 4)

1.4. pH

pH values showed a decreasing trend from surface to bottom during all seasons except in winter . The surface water showed a pH range from 7.7 to 9.5 . Among the depths pH varied between 7.6 – 8.6 , 7.5 – 8.1 ,7.3 – 7.6 and 6.5 – 6.8 at 3m ,6m , 9m and 12 m respectively .The bottom waters showed acidic pH values through out the study period. During the circulation period from December to February pH showed a slight variations from surface to bottom while as in stagnation period, the pH at all depths showed vertical difference resulting in the formation of a pH gradient with depth(Fig 5).

1.5. DISSOLVED OXYGEN

Oxygen concentration in surface water ranged from 5.2 to 10.7 mg/l .Oxygen concentration depicted significant seasonal variations with regard to depth. During stagnation period a gradual decline from surface to 9m depth was recorded which finally resulted in its complete absence from July to October at 9m depth and complete absence at 12m depth depicting anoxic condition(Fig 6) .

1.6. FREE CARBON DIOXIDE

The surface water showed absence of free carbon dioxide from May to September . At 3m depth carbon dioxide was absent from May to July. A distinct vertical gradient was recorded from bottom to surface layers. In bottom layer (12m depth) concentration of carbon dioxide was quite high as compared to upper layers. It was recorded at all depths during circulation periods . A little variation was recorded from surface to bottom during circulation period(Fig 7).

1.7. TOTAL ALKALINITY

Total alkalinity at surface ranged from 112 mg/l to 144mg/l while at the bottom it fluctuated between 154 – 210 mg/l . Carbonates were present from May to September in surface water and 3m depth. During rest of the period alkalinity was mainly due to bicarbonates . From 6m to 12m depth carbonates were absent and total alkalinity was mainly due to bicarbonates and showed a considerable increase in the content with increasing depth(Fig8) .

1.8. HARDNESS

Hardness values during stagnation period at surface waters ranged from 87 to 146mg/l .It showed increasing trend from surface to bottom and therefore a vertical gradient was observed . At 12m depth hardness values were high. During circulation period from December to March, a little variation was observed from surface to bottom due to thorough mixing of water(Fig 9).

1.9. CALCIUM

Calcium hardness showed a variation during stagnation period at surface water from 46 to 65 mg/l. It showed an increasing trend from surface to bottom during stagnation period while as during circulation period a little variation from surface to bottom was recorded . Highest concentration was recorded at 12m dept and lowest at surface(Fig 10).

IV.DISCUSSION

A close relationship between water and air temperature was recorded, with maximum values in summer and minimum in winter, which is in line with the findings of [5]. Manasbal Lake undergoes seasonal changes with regard to the temperature density profile which produces characteristic pattern of circulation and stratification in deep waters [6]. Thermal stratification in this lake was observed from March to November and the lake circulated during December to February. The present data recorded maximum transparency in summer in the water body. Water was clear and light penetration was observed up to the maximum depth of 4.5m. Low light penetration was recorded at the start of stagnation period in spring (March). Thermal stratification was found to influence transparency [7]. In Manasbal conductivity values were minimum during summer at surface . It may be that in this water body the ions released in decomposition are quickly taken up by plants during the growing season [8]. High conductivity values in bottom layers seems to be attributed to the inflow of domestic sewage , agricultural run off and decomposition of organic matter which can sustain a gradient of dissolved substances . Dissolved oxygen concentration was higher in spring, while the lowest values were observed in summer. It may be that during spring, when the atmospheric temperature increases, the plant community in the water body starts blooming, leading to release of large quantities of dissolved oxygen in to the water column, thereby enhancing the oxygen content in the water column . According to Broker and Edward [9] the decline in photosynthesis and increase in metabolism of dying vegetation may result in a deficiency of oxygen and excessive amount of carbon dioxide in the aquatic system. Distribution of oxygen in thermally stratified lakes is controlled by a combination of solubility condition, inputs from photosynthesis and losses to metabolic oxidation [10]. According to [11]the lakes which experience thermal stratification develop oxygen gradient. In Manasbal a vertical oxygen gradient was evident during thermal stratification; the difference in oxygen content between various depths became quite prominent with the establishment of thermocline in March. The bottom was always anoxic and the extent of anoxic condition increased up to 9m during latter part of summer stratification, July to October and November.

pH values recorded in this study indicated that the lake water is alkaline. The alkaline nature of Kashmir lakes in general may be due to the presence of calcium rich rocks in catchment areas [12]. Hydrogen ion concentration showed an increase with increasing water temperature . Maximum pH values in summer may be attributable to increased photosynthetic activity which is accelerated by rising temperature . High pH values in summer result from rapid removal and assimilation of dissolved carbon dioxide from the water. The lower pH values in the deeper layers of the Manasbal lake could be explained on the basis that the process of decomposition going on simultaneously results in the release of free carbon dioxide, which reduces the pH. The bottom layer of Manasbal lake revealed slightly acidic water throughout the study period, indicating that only decomposition process was going on there. A definite pattern in the fluctuation of pH from surface to bottom in relation to the thermal stratification of the lake was observed . The accumulation of CO_2 results in a decrease in pH at bottom layers .

Bicarbonate alkalinity was maximum in bottom layers . A reverse clinograde alkalinity curve was found decreasing from bottom to surface .The total alkalinity values have been used to differentiate soft and hard water bodies. According to [13] lakes having total alkalinity values up to 40mg /l are considered “Soft”, those with 40-90/l as “Medium hard” and those with values over 90 mg/ l as “Hard type”. When this classification is applied to the present lake, it becomes clear that the Lake is a typical “hard water’’ .Calcium accounted for most of the hardness in the lake because of predominance of lime rich rocks in the catchment. The calcium content in the bottom layer in Manasbal lake was comparatively higher than surface water. Decrease of concentration of calcium in epilimnion and metalimnion are related largely to rapid increases in the rate of photosynthesis by phytoplankton [14], resulting in the formation of calcium carbonate precipitate (Marl) on the leaves of macrophytes.[15] has classified water bodies into 3 categories on the basis of calcium level, viz., poor (less than 10 mg /l), medium (from 10 –25mg/l) and rich (more than 25 mg/l). According to this classification present lake can be considered as “calcium rich water”.

V.CONCLUSION

The Lake experiences thermal stratification with regard to the temperature density profile . High conductivity , Carbon dioxide , bicarbonate alkalinity values in bottom layers was attributed to accumulation and decomposition of organic matter.A vertical oxygen gradient was evident during thermal stratification; the difference in oxygen content between various depths became quite prominent with the establishment of thermocline. The bottom layer of the lake revealed slightly acidic water indicating that only decomposition process was going on there. A definite pattern in the fluctuation of pH from surface to bottom in relation to the thermal stratification of the lake was observed . Calcium accounted for most of the hardness in the lake because of predominance of lime rich rocks in the catchment and can be considered as “calcium rich water”.

VI.ACKNOWLEDGEMENTS

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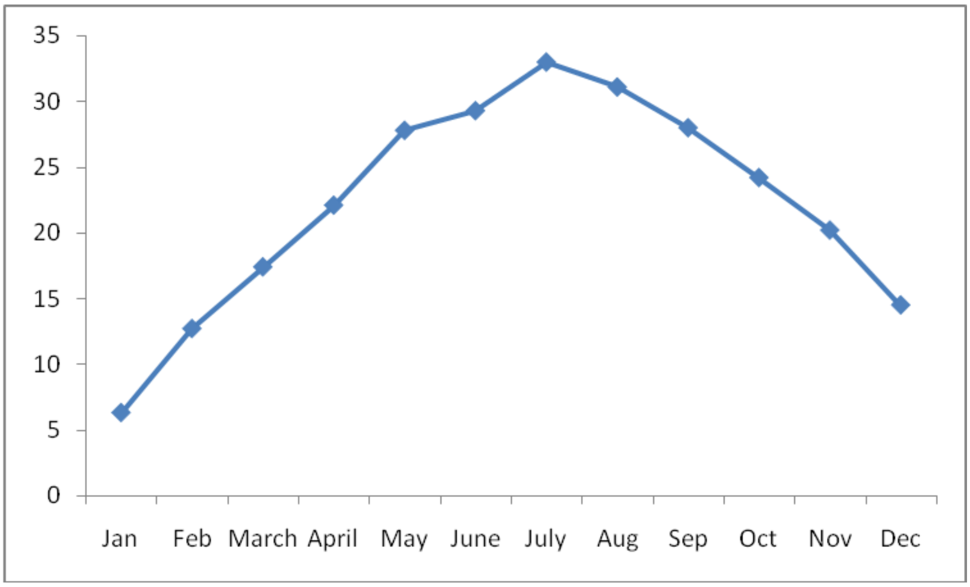

Fig 1.Air temperature

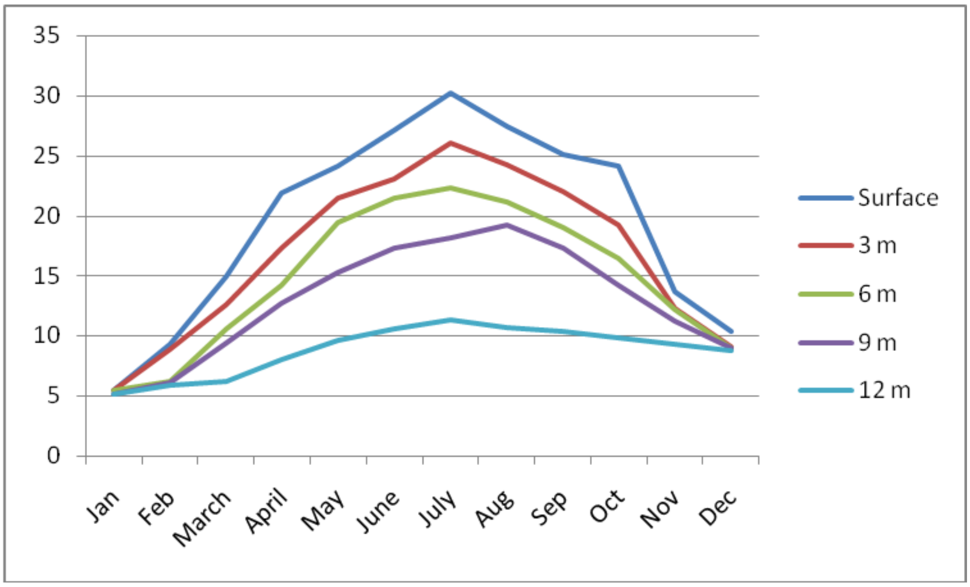

Fig 2 .Water temperature

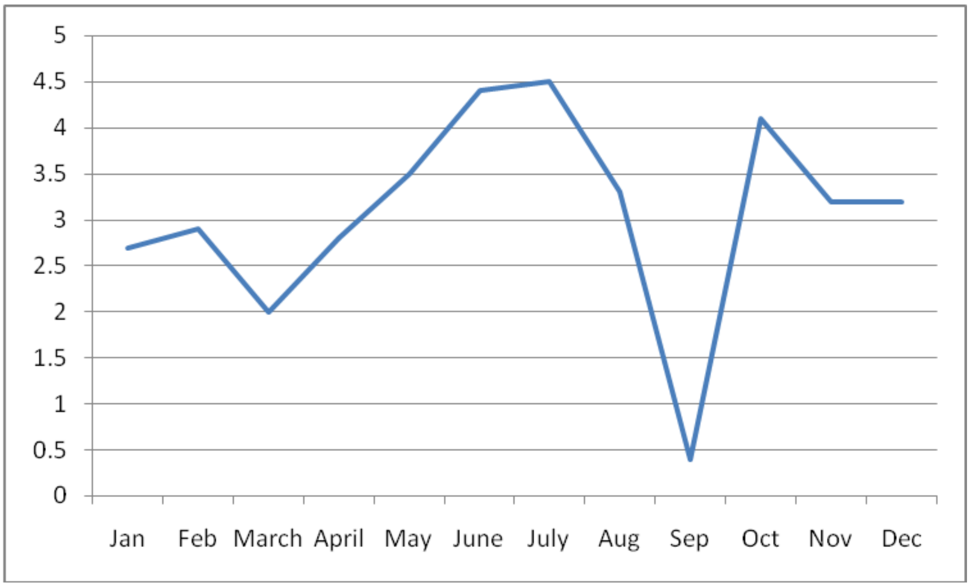

Fig 3. Transparency

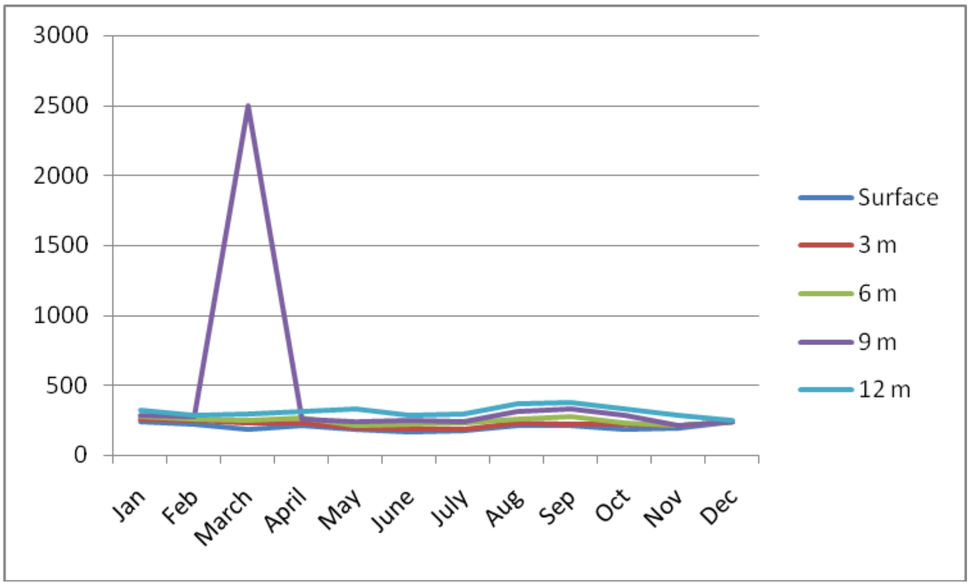

Fig 4 . Conductivity

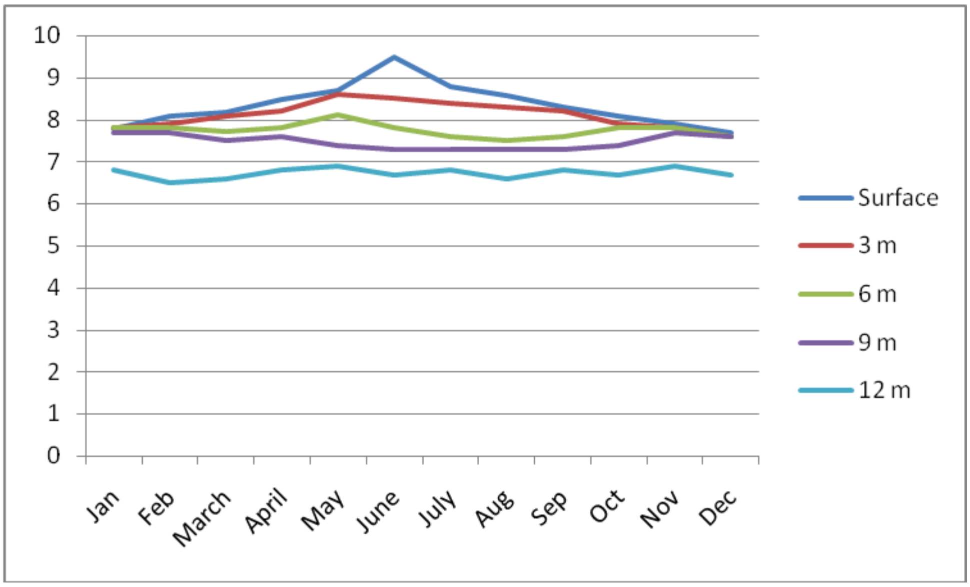

Fig 5 . pH

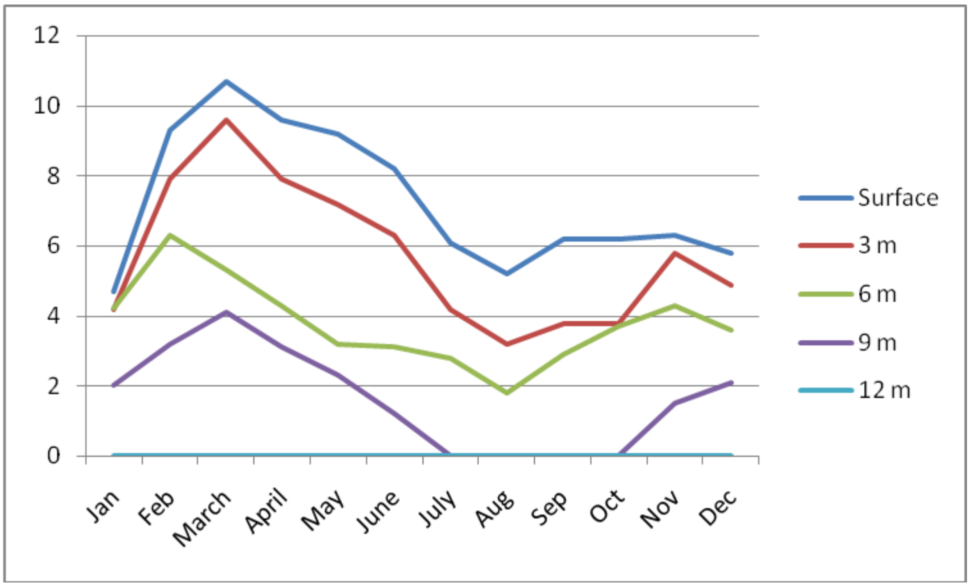

Fig 6 .Dissolved oxygen

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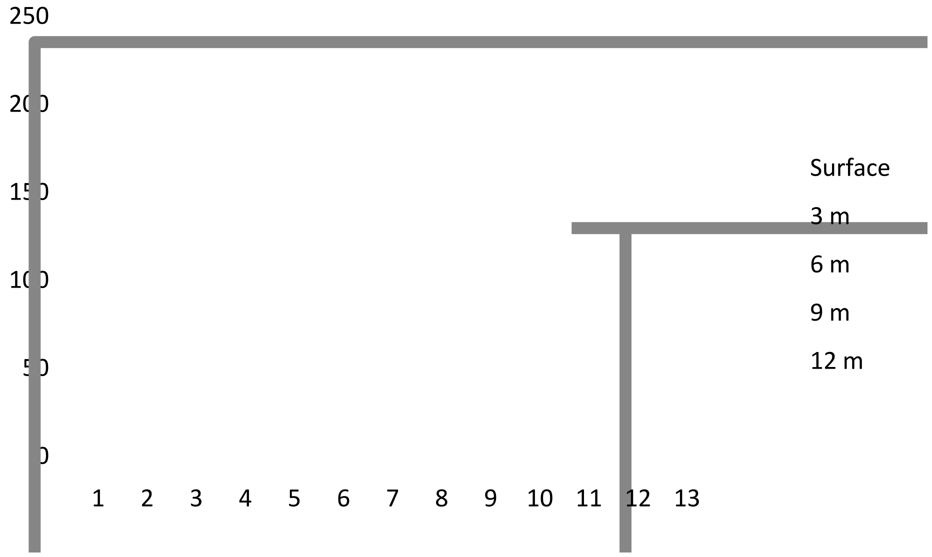

Fig 7 . Carbon dioxide

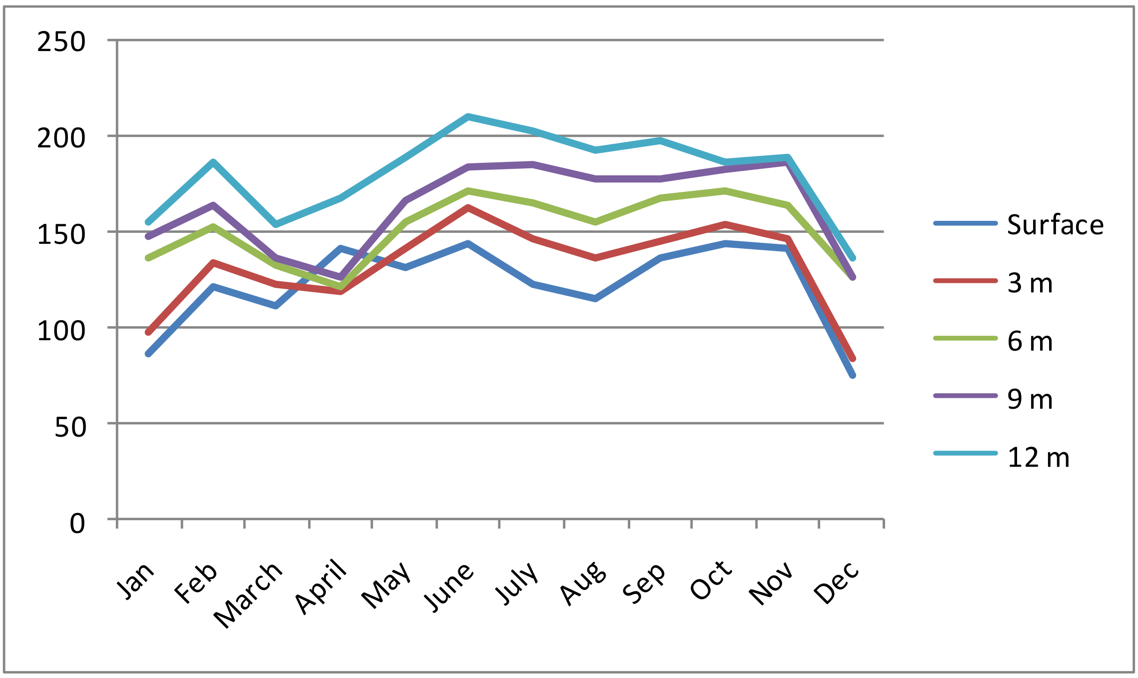

Fig 8 . Alkalinity

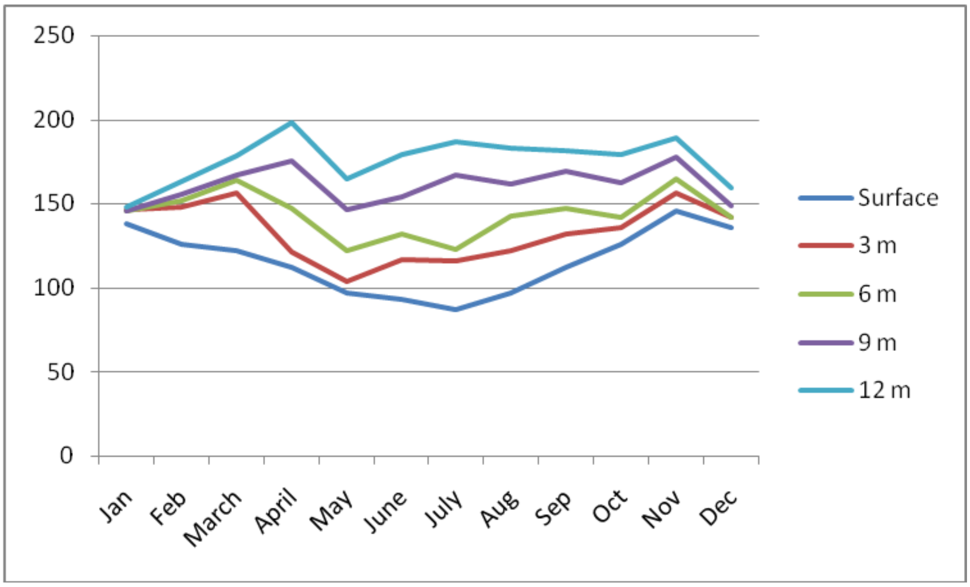

Fig 9 . Total hardness

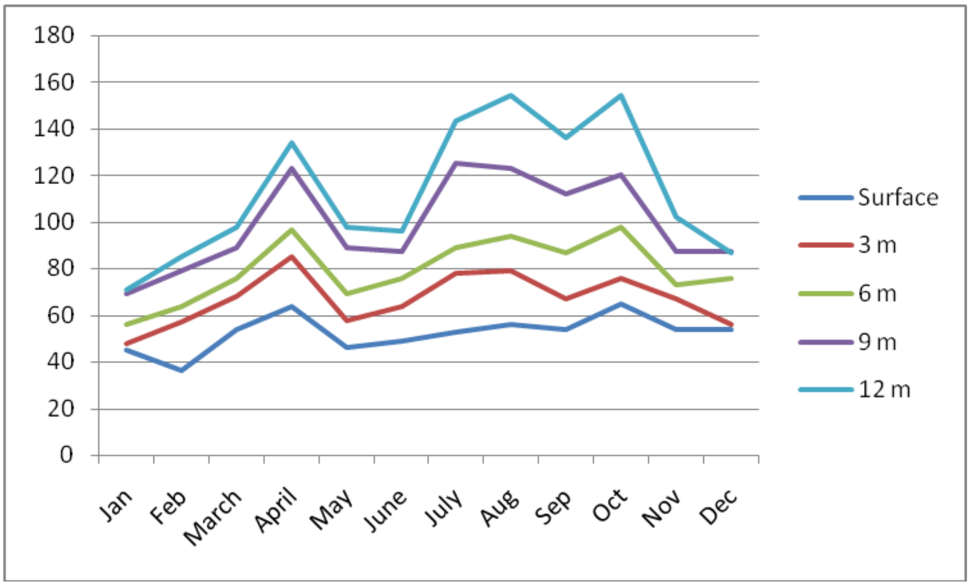

Fig 10. Calcium hardness