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LIMNOLOGICAL STUDIES OF A FRESHWATER TROPICAL IMPOUNDMENT - POWAI LAKE I.MORPHOMETRY AND PHYSICAL FEATURES

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ABSTRACT

The Powai lake, an impoundment, came into existence in 1891 when the riverlet Dhanisar was dammed to conserve rainwater for drinking purpose. But the water was found unpotable and the lake was leased out to the Angling Association, Bombay, exclusively for angling and sports. The lake (Lat. 19°8' N and 72°54' E) is located about 27 km in the northeast of Bombay city at a height of 55m above MSL. It is rainfed with an average rainfaull of 2,400 mm. The maximum waterspread area is 220 ha with a maximum capacity of 8.11 million m^3 in the peak monsoon period when the water overflows the dam. There is no drawdown from the lake. Fluctuation in the water level is mainly due to evaporation and percolation. Transparency is low mainly due to suspended organic particles. There is hardly any difference in the water temperatures of surface and bottom, hence the annual heat budget is low at 2,818 cal m^{-2}.

INTRODUCTION

India has a large number of reservoirs covering an approximate 3 million ha of waterspread area. Development of fisherie in them can form a significant and most valuable additiona source of protein. Study on the ecology of these aquatic biotope thus becomes necessary to evaluate their productive potential. Thienemann (1954) rightly suggested that the tropical water

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should be investigated with respect to their environmental parameters.

The present study (November 1975 - December 1976) embodies the results of the investigations of some aspects of ecology of the Powai lake, a tropical impoundment.

STUDY AREA

Bombay Municipality's drinking water scheme resulted in the formation of a few freshwater artifical lakes - Vihar(1858), Tulsi (1879), and Powai (1891) having water spread areas of 7.28, 1.35 and 2.10 km^2 respectively. Powai lake came into existence when a 10 m high dam was erected across the seasonal riverlet, Dhanisar to conserve rain water, but the lake water was found unpotable and the lake was leased out to the Angling Association, Bombay, exclusively for angling and sports

Powai lake is about 27 km away in the north-east of Bombay city and is located at a height of 55 above MSL with geographica ordinates of 19°8' N and 72°54'E. It is rain-fed with an annual average rainfall of 2,440 mm having catchment area of 6.68 km^2. The maximum water spread area in a peak monsoon (August-September) is 220 ha, with a total water content capacity of 5,455 Mega litres. In the lean season (May/June) the water spread area gets reduced to 180 ha with water capacity of 1,809 Mega litres.

MATERIAL AND METHODS

The meterological data was taken from the Santa Cruz Air Port near Powai lake. The morphometric parameters were calculated as per Hutchinson(1975), while the bathymetric map was prepared by sounding the lake bottom with a marked rope having 2 kg weight tied to one end. Distance was estimated by using a definite number of oar strokes (Welch, 1948). Water level fluctuations were recorded from a permanent gange fixed on the dam wall and transparency was taken using Scchi disc. Surface water temperature was recorded with the help of centrigrade thermometer and bottom water temperature by using Nansen bottle fixed with reversing thermometer. Heat budger was computed as per Hutchinson (1957).

RESULTS AND DISCUSSION

Climatic features : In the coastal regions in tropics, the seasons are not clearly distinguished like in temparate regions, here rainfall plays a major role (Carter, 1960). Bombay city being located as 7 islands, surrounded by the backwaters of the Arabian Sea, the weather remains humid throughout the year. The most characteristic feature of Bombay climate is that there is no distinct summer or winter. However, the climate can be distinguished in three seasons, viz., premonsoon, monsoon and postmonsoon, according to rainfall and temperature.

Premonsoon (March-June) : It is characterised by long hours of sunshine and comparative high temperature, maximum being in May/June. Wind velocity also begins to rise from March and reaches maximum (14.7 km/hr) in June with severe thunder showers towards the end of the season (table 1.).

Monsoon (July-October) : The normal onset of monsoon is in late June or early July with mostly over cast sky. The maximum (65%) rainfall is during July-August. Once the monsoon is well set, there is a fall in the temperature but near the end of the season, a short slightly warmer period is not uncommon.

Postmonsoon (November-February) : It is characterised by fairly long hours of sunshine and comparative low temperaturte, minimum being in January/February. During the season there is a little or no rain and wind velocity is also minimum (table 1).

Morphometry : The main morphometric and bathymetric features are given in table 2 & 3. The total water spread area of the lake is 2.16 km^{-2}, with total estimated volume of 8.11 x $10^{6}m^{-3}$. The lake is shallow with a mean depth of 3.86 m. The shore line development is of low order (1.08), indicating sub circular character of the lake. The volume development index (1.72), greater than unity points that the basin wall is concave towards the water surface. The ratio between Z/Zm (9.576) indicates saucer-shaped basin. Rawson (1958) showed importance of morphometric factors on the productivity of lakes. He obtained an inverse relationship between mean depth and productivity. As the mean depth in Powai Lake is of low order (3.86) and there is great circulation of nutrients from surface to bottom, the lake can be put under productive class of waters.

TABLE 1: METEOROLOGICAL AND PHYSICAL PARAMETERS OF POWAI LAKE (DURING 1975-76)

Months	Air temp. (°C)	Water temperature Surface (°C)	Water temperature Bottom (°C)	Relative humidity (%)	Sun shine (hrs/m)	Transparency (cm)	Water level (m)	Rainfall (mm)	Wind velo city (km/hr)
MARCH	31.9	27.3	27.1	54.4	260	60	7.45	-	8.8
APRIL	31.8	29.8	29.6	64.1	289	55	7.06	-	10.1
MAY	32.2	30.6	30.4	68.3	263	45	6.70	-	10.0
JUNE	30.2	30.6	29.7	79.7	127	54	7.66	462.3	14.7
JULY	29.4	28.1	27.8	86.1	80	50	8.52	484.6	15.5
AUGUST	29.4	28.5	28.2	86.7	600	48	9.85	670.6	13.6
SEPTEMBER	30.0	29.0	28.7	84.1	103	50	10.00	270.1	8.9
OCTOBER	31.0	30.1	29.8	72.6	143	55	9.60	50.5	6.0
NOVEMBER	30.3	29.6	28.8	51.3	277	58	9.12	2.0	6.1
DECEMBER	29.2	27.0	26.6	56.0	243	60	8.65	-	6.0
JANUARY	28.9	23.0	22.6	57.7	230	75	8.20	-	6.9
FEBRUARY	28.0	22.8	22.4	54.7	264	65	7.92	-	7.8

TABLE 2 : MORPHOMETRIC FEATURES OF POWAI LAKE

1.	Maximum length (L) km	= 1.28
2.	Maximum width (bx) Km	= 1.27
3.	Mean width ($\bar{b}$)	= 0.36
4.	Maximum depth (Zm) m	= 10.00
5.	Mean depth ($\bar{Z}$) m	= 3.86
6.	Surface arfea (A) km^2	= 2.10
7.	Length of shore line (L) km	= 5.54
8.	Index of shore line development (DL)	= 1.08
9.	Total volume (V) x $10^6 m^3$	= 8.11
10.	Index of volume development (DV)	= 1.72
11.	Mean depth/Maximum depth ($\bar{Z}$/Zm)	= 0.576

Bathymetric features : The contour-wise water area distribution shows that the first contour encloses an area of 2.2 km^2 (44.6% of total area), second contour 1.4 km^2 (28.6%), third contour 0.81 km^2 (16.3%), fourth 0.40 km^2 (8.1%), fifth 0.10 km^2 (2.0%) and sixth contour only 0.02 km^2 (0.4%).

Rainfall : Bombay receives south-west monsoon during June/July-September/October with annual rainfall of 2,440 mm. During the present study the maximum precipitation was in July (984.6 mm - 40.4%), and in August rainfall was 670.6 mm (27.5%) while in June and September it was 462.3 mm (19.0%) and 270.1 mm (11.0%) respectively (table 1).

Water level : Water is not drawn from the lake; the only outflow is during the peak monsoon when lake water overflows the dam. This overflow is generaly for 50-60 days during August and September. There was a close relationship between the lake water level and the amount of inflow rainwater from the catchment area; the lowest water level (5.13m) was recorded in May and maximum (6.70m) in August/September with a fluctuation of 1.57m. As the water was not drawn from the lake, the decrease in the water level was due to evaporation and percolation. It was estimated that the lake last more than 33% of its capacity annually through evaporation. Farrel et al.(1979) also recorded such high loss (30%) due to evaporation from a tropial lake in north-western Queensland. The shallow nature of the lake and high surface to depth ratio is considered very congenial for such evaproation (Hutchinson, 1957).

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Transparency : The transparency in the lake was gene-'ally low, ranging from 45 to 75 (Table 1). The lowest .ight penetration was in May (45cm) in the premonsoon and the highest secchi disc reading (75 cm) in January in the postmonsoon, while it oscillated from 48 to 54 :m during the monsoon. The low visibility was due to suspended organic matter which could be because of wind and wave action and the shallowness of the lake.

Thermal dynamics : Bombay weather remained humid (51.3 - 36.7, av. 68.2%) throughout the year, hence there was hardly any difference between ambient and lake water temperatures (Fig.1 & Table 1). The coldest ambient temperature was recorded in February (28.0°C) and the hottest in May (32.2°C) with a difference of 4.2°C only. The difference in air temperature during the premonsoon was 2.0°C (30.2-32.2°C),

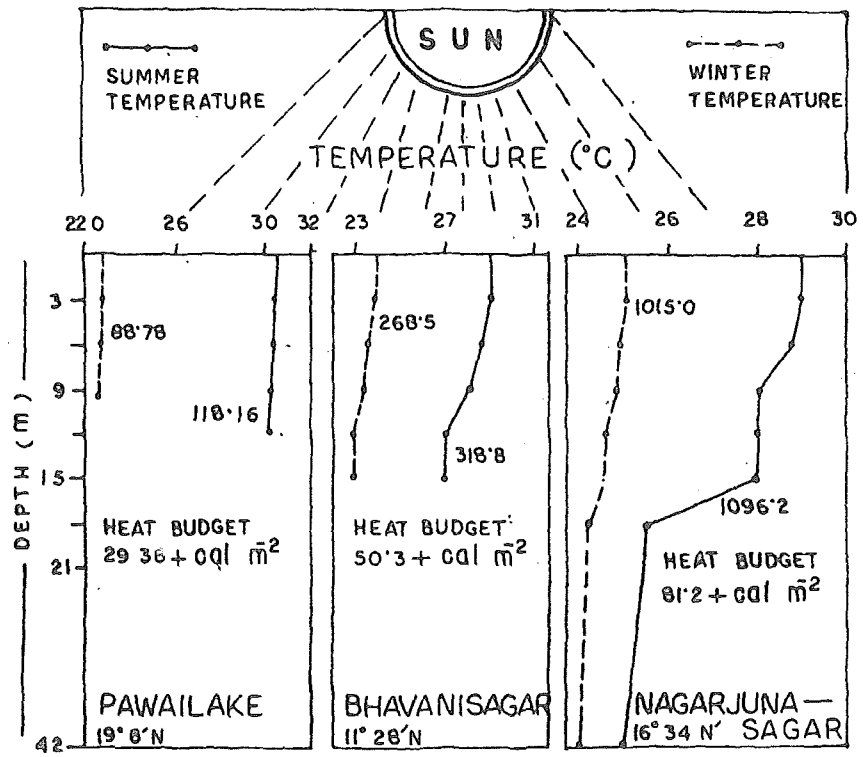

Fig.1 : Heat Budget in Three Reserviors.

monsoon 1.6°C (29.4-31.0°C) and during the postmonsoon it was 1.6°C (28.0-29.6°C). The difference in water temperature during the respective seasons was 3.3°C (27.3-30.6°C), 2.0°C (28.1 - 30.1°C) and 3.6 (22.8 - 26.4°C)

The termal gradiant of 1.0°C and 0.9°C was recorded between

Table 3 : Area of contour with water capacity of Powai Lake during 1975-76.

Depth of contour (m)	Area of contour km^{-2}	% of area	Capacity (mega litres)
59	2.20	44.6	5,455
58	1.40	28.6	3,165
56	0.81	16.3	1,415
55	0.40	08.1	478
53	0.10	02.0	110
52	0.02	00.4	15

surface and bottom waters in December and June, while in rest of the months the difference ranged from 0.2 to 0.4°C. In general isothermal conditions prevailed throughout the period of study. This small difference may be due to shallow depth and complete mixing from surface to bottom because of wind and wave action, thus not allowing any thermal stratification to establish. Singh (1960), Munawar (1970), Goutam (1982) and Vyal *et al.*(1982)recorded similar conditions in their respective studies.

Heat budget : Annual heat budget was computed with the formula proposed by Welch (1948): Dm (Tm^S-Tm^W), where Dm = mean depth, Tm^S and Tm^W are mean summer and winter temperatures of lake water.

Hea budget of Powai lake was estimated as 29.38 t m^{-2} which is quite low in comparison to many other tropical reservoirs, like Rihand (11.8 t cal m^{-2}), (Nagarjunasagar (81.2t cal m^{-2}), and Bhavanisagar (50.3 t cal m^{-2}), Natarajan and Pathak, 1983). Heat budget of water bodies differ enormously due to their geographical location, morphometry, thermal gradient and mean depth. Low heat budget in the lake may be attributed to low mean depth and less seasonal fluctuations in water temperature. Similar observations have been made by Natarajan and Pathak (1983) in some tropical impoundments. (Fig.1)

Low heat budget of a small water body indicates inefficient heating (Hutchinson, 1957). In shallow lakes the heating of the bottom mud is proportionately more (Nanmonn, 1953). while studying the lake Hula, Jordon Valley (Z = 1.7 m) estimated the heat taken by the bottom wasmore (1,400 g cal - 62.5%) when the annual heat budget was 2,240 g cal. In the present study this could be the probable reason for the low heat budget in the Powai lake.

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