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Studies on the Morphometric Dimensiosn of Two Ponds of Gaya

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Abstract

Studies made pertaining to morphometric features, comprising of the size, shape, and connectivity of water bodies have exhibited important effects on ecological communities and ecosystem processes for the two ponds of Bihar. Intensive alteration of water bodies being reflected by the morphometric analysis appears to give a significant ecological information.

Introduction:

Morphometry is the measurement of external form or shape of a selected water body. It is that branch of limnology which deals with the measurement of significant morphological features of any basin and its included water mass is known as *morphometry*. Morphometry defines a physical dimension and involves the quantification and measurement of any basin. These dimensions influence the water quality and productivity levels. Morphological features, age and geology of the lake basin along with the level of human interference have a direct and significant bearing on the structural and functional attributes of the aquatic habitats. These include, broadly, length, width and depth features as well as various ratios. Details of these observations for Zindapur Pond (Z.P.) and Baitorni Pond (B.P) have been tabulated in Table 1.

Material and Methods:

Morphometry, the discipline of measurement of pond in question were studied because some fundamental ecological conditions are directly dependent upon structural relations of the water. Following morphometric attributes were taken into account, Michael[1] (1986), Saxena[2] (1987), Singh[3] (1982).

Maximum Effective Length:

It denoted the length of line connecting two most remote extremities of the body of water along which wind and wave action occur without any kind of interruption. In case of R.S. & V.S. Maximum Length and Maximum effective length were identical. It was measured in metre at monthly intervals.

Maximum Effective Width:

It denoted the length of straight line connecting most remote transverse extremities of a body of water along which wind and wave action occurred without any kind of land interruption. It was also identical to maximum width. It was measured in metre at monthly intervals.

Depth:

Depth, the vertical distance between the surface and underlying bottom were studied. Maximum, minimum and mean depths were calculated in metre.

Depth Ratio:

It was computed by dividing maximum depth with mean depth.

Boundary Analysis:

The length and width of the pond including water & dry marginal area were calculated and were expressed as total boundary area in m^2.

Length Ratio (RL):

It was calculated by following formula :-

$$RL = \frac{L}{Ln - 1}$$

Where, L = Sum of total readings of length in a year

Ln = Number of reading of length in a year

Area :

The surface area of water spread was calculated by multiplying Maximum effective length with Maximim effective width. This was repeated every month the values were expressed in m^2.

Average Water Volume :

Volume of water was computed at an interval of one month and recorded in m^3. It was determined by multiplying area with the mean depth of the pond.

V/SA Ratio:

It was calculated by dividing volume by surface area.

Slope Analysis :

Slope analysis was studied by using the following formula and values were expressed in terms of Natural Tengential Value (o – , – “) :-

$$S = \frac{C_1 + C_2}{2} . \frac{I}{A.B.}$$

Where , C_1+C_2 = Average Lengh of Contour.

I = Contour interval.

A.B= Inter contoural area.

Bathymetry :-

A bathymetric or contour map which denoted the depth at different points in the water body was prepared.

Index of Lake Performance :-

Index of lake performance was computed by dividing Maximum volume by Maximum Area.

$$I = \frac{VO}{AO}$$

Where, VO = Maximum volume

AO = Maximum Area.

Hypsometry :

Hypsometric details were expressed in the terms of total area (%) and cumulative area (%) with the help of mean depth and area of the pond.

Total Area Percentage :

This was calculated by using the following formula :

$$\text{Total area (\%)} = \frac{\text{Area of the month}}{\text{Sum of area of 12 months}} \times 100$$

Cumulative Area Percentage :

Total area percentage was added to one another successively, so as to find the cumulative area percentage.

Result :

Table 1 : Attributes of lacational details.

ATTRIBUTES	**TOWN- SHIP, GAYA**	
Latitude Longitude Altitude Town area	24° - 25' – 36" to 24° - 50' – 30" North 84° - 57' – 58" to 85° - 3' – 18" East 126.76 mts. Above M.S.L. 4941.00 Sq. Km	
Water-Body	Ponds	
	Zindapur pond	**Baitarni pond**
Outer length Outer width Outer area Length ration (RL) Average slope (S) Annual Heat Budget	217.66 m. 93.760 m. 20427.16 sqm 1.069 26° - 02' – 0" 14.972	155.3606 m 108.5736 m. 16868.06 sq. m 1.077 26° - 33' - 04" 27.686
	K.Cal. cm. yr.	K. Cal. Cm. yr.

RESULTS

Morphometric observations revealed a monthly variation in maximum effective length (m); although the variation was not more. This parameter was at the lowest scale of 212.03 in May in JindapurPond and 149.033 for May in Baitarni Pond, whereas its highest share was 215.58 and 153.091 in August, with an annual average of 213.501 and 151.137 respectively. Maximum effective width (m) also varied from89.09 and 105.129 in May to 91.29 and 107.290 in August, with an annual average of 90.10 and 105.602 respectively in Jindapur Pond and Baitarni Pond.

Lowest value of mean depth (m) were observed in May as 2.849 and 4.000 while its highest one was recorded as 3.85 and 5.599 in August in Jindapur Pond and Baitarni Pond respectively. Surface area (m^2) of the pond was at its lowest figure of 18889.752 in May whereas August witnessed the highest figure of 19680.298 with annual average of 19237.007 in Jindapur Pond and lowest figure of 15667.690 in May and 16425.133 as highest figure with annual average of 15960. 898 in Baitarni Pond. Water volume (m^3) of the pond was recorded minimum in the month of May as 48149.977 and 62200.729 in Jindapur Pond and Baitarni Pond respectively while its maximum was observed as

69865.057 and 91471.565 in August in both the pond respecrtively; the annual average, remained 59134.108 and 72153.691 respectively. A lowest V/SA (Volume/Surface area) ratio was calculated to the tune of 2.549 and 3.97 in May in both the ponds respectively while the highest was shared by August at 3.550 in Jindapur Pond 5.569 in Baitarni Pond; the annual average remained 3.074 and 4.520 in same manner.

Regarding depth features, the lowest maximum depth (m) were 3.30 in Jindapur Pond and 4.55 in Baitarni Pond, which featured in May in both the ponds whereas the highest maximum depth was 4.30 and 6.92 which figured in August with an annual average of 3.821 and 5.193 respectively. In the same way the lowest minimum depth (m) of 2.40 and 3.45 were witnessed in May whereas the highest of the same at 3.40 figured in August and 4.30 in July with an annual average of 2.921 and 3.90 respectively in Jindapur Pond and Baitarni Pond. Results of mean depth have been mentioned in the previous paragraph. The Zm/mnZ ration were lowest in August as 1.1168 and 1.6160 and highest in May as 1.1578 and 1.318 with an annual average of 1.1346 and 1.332 respectively in Jindapur Pond and Baitarni Pond. The z/zm ratio was at its lowest scale of 0.863 in May in Jindapur Pond and 0.879 in May in Baitarni Pond and became highest at 0.895 in August and 0.954 in December with an annual average of 0.881 and 0.878 in Jindapur Pond and Baitarni Pond respectively. Volume development was minimum in May 2.589 in Jindapur Pond and 2.612 in the month of April in Baitarni Pond maximum in August 2.685, the average annual one was 2.643 in Jindapur Pond and in Baitairni Pond maximum 2.862 in December with the annual average of 2.636.

In order to study the hypsometric details the percentage total area was observed to be the lowest one in May as 8.182 and highest as 8.525 in August with an annual account of area occupation as 99.884 in Jindapur Pond and the lowest one in May as 8.180 and highest as 8.575 in August with an annual account of area occupation as 99.894 in Baitarni Pond.

DISCUSSION

Morphometric features are important as they indicate bio-dynamics ofthe water bodies (Hutchinson,[4] 1975). In order to study the features associatedwith the depth profile of the ponds, bathymetric maps were constructed, which gave an information on depth contour or isobath interval of centimeters.

Theratios of z: zm, in J.P. & B.P. was 0.881 and 0.878 (the annual average), which were indicative of a conical depression (Hutchinson[4], 1975; Khanka,[5] 1989). In many casese.g.Caldera lakes, Graben lakes and Fjord lakes the ratio hasexceeded0.5,however a ratio > 0.33 has been accountedforconical depressions (Hutchinson[4], 1975). Very low values of theratio are found only in lakes with deep holes; either sink due to solution or sublacustrine kettles due to the former presence of burried stagnant ice blocks. When a number of deeps of differing area and profundity occur within a given lake, the chemicalevents in the water at the bottom of the different depressionsmay differ somewhat at times of stratification, giving rise to submerged depression individuality (Hutchinson[4], 1975).

The slope of the ponds were 26° -02'-0" and 26° -33'-04"with a maximum depth of 3.82 and 5.19 m, minimum depth of 2.92and3.90 m and an average depth of 3.37 and 4.54 m, occupying a average area to the tune of 19,237.007 (m^2) and 15,960.898 (m^2) respectively, which were indicative of a moderately steep slope (kankka[5], 1989)

Mean depth has been considered as an important dimension since Thienemann (1927) suggested that in German lakes $\bar{z}$ values exceeding 18 m feature as oligotrophy whereas shallower lakes were more productive and belonged to eutrophic series. Similar observation have been made by Rawson[6] (1953[6], 1955[7]) and Hayes[8] (1957). On these lines, the shallowness of Jindapur pond and Baitarni pond are indicative of eutrophy, which has further been confirmed by various other observations. Besides, Gorham[9] (1958b) further discussed mean depth and biological productivity, pointing out that Rawson's data fit in a curve of photosynthetic zone. Further, Deevey[10] (1955) opined that depletion in depth profile is indicative of more age of the water body. This seems to be agreeable as both the ponds of this historic city are very old.

Average effective length of 213.501 (m) 151.137 (m) and width of 90.1 and 105.602 (m) were indicative of a rectangular shape. The annual average volume of 59134.108 and 72153.691 (m^3) and V/SA ration of 2.549 and 3.97 were suggestive of the fact that the basin walls were steep towards the water surface and this steep naturewas also confirmed by the analysis of slope angle. Average volume development (DV) figure was 2.643 and 2.636 indicated that pond basin walls become convex towards the water surface at some of the places, however, at some places the walls are very steep (scraps) towards the water surface. Similar findings have been reported in the study of Kumayun lakes by Khanka (1989). On account of the above observations the steep nature of the pond basin wall have finally been suggested. Hyposometric studies (Table 1) have also indicated the shallow and steep nature of both the ponds (Crowe[11], 1952).

Shallow lakes with relatively great areas have been attributed to contain high indices and DV figures are usually more than one (Deevey[12], 1955). Our observations are in agreement with this, as in the shallow ponds of our investigation the average DV was 2.64 and 2.63 and the same had higher indices, establishing a state of mild pollution. The calculation of rain factor and index of humidity account for the arid nature of climate in the entire period of investigationMiller[13], 1951).This arid nature was further established by Martonne'sindex. The empirical relationships betweenrainfall, temperature and evaporation also suggest a state of aridity (Thornthwaite[14], 1931). The thermal efficiency factor, produced through corresponding temperature categories (Thornthwaite[14], 1931) was suggestive of a good quality of thermalefficiency.'It has generally been suggested that inlentic waterbodies, where outlets are not provided a state of balance between inflow and evaporation is observed. Rain water, during monsoon, fills the water bodies to the capacity and water evaporates the rest of the year. The evaporation as well as evapo-transpiration increases the concentration of many chemical constituents in water. The annual water loss due to evaporation may be high and result in significant reduction in the surface area and depth of the pond. The inflow of large volume of water during inundation from the surrounding areas also changes the physico-chemical profile of the pond. This situation is in accordance with Morgan and Kalk (1970) who have opined that evaporation and evapo-transpiration are inversely proportional to the rain fall. They further pointed out that the water chemistry is influenced by the geographical history of the fall in water levels, by drainage in the catchment area, by seasonal changes in the area and its exposed mud, by evaporation and by local rainfall.

The state of very high significant correlation of atmospheric temperature with water quality parameters (of J.P. & B.P.), like Temperature, Conductivity, Total solids, Total dissolved solids, Calcium, Magnesium, Alkalinity, Nitrate and 137.22 Free CO and additionally for pH, D.O., in Baitarni pond may be accounted for precipitation-evaporation phenomena (Shastree and Islam, 1990). Add up of Calcium, Magnesium and Solids is related to human activities and additions from municipal waste water. The state of non-significant correlation profile with rest of the parameters may be indicative that these parameters are exhibiting a corresponding behaviour with the depletion of atmospheric temperature. A minor shift in the correlation for both the ponds may be on account of varied morphometry, human interference and sewage supply.

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