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Physico-geographical and morphometric features of two shallow Himalayan lakes

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Abstract

The paper discusses some hydrographic and morphometric features of two Himalayan lakes of Kashmir. The lakes are shallow water bodies which differ in their trophic status. The impact of catchment areas on the two lakes is also discussed using some indices.

Key words: Trigamsar, Khanpursar, catchment area, eutrophication.

1. Introduction

Kashmir valley (32°17′–37°5′ N latitude and 72°70′–80°30′ E longitude) lies as an oval bowl between the Zanskar range in the north and Dhaulader–Pirpanjal range in the south. The valley is 135 km long and 35 km broad at the middle and lies at an altitude of 1585 masl. It is drained by a narrow gorge of river Jhelum down Baramulla. In its course the river flows through a plain of low-level recent alluvium. The alluvium has been formed by the river in flood and abounds in freshwater lakes.

Khanpursar and Trigamsar are two such flat land valley lakes situated at a distance of 24 km from Srinagar in the Ganderbal tehsil of Srinagar district.

A detailed limnological survey of the lakes was carried out between September 1983 and February 1985.

2. Description of the lakes

Khanpursar lake is a semidrainage type with a permanent outflow connected to river Jhelum. A few ephemeral channels flow into the lake during most part of the year bringing in agricultural run-off and precipitation. The run-off water brings in allochthonous material into the lake including major and minor plant nutrients. The lake is surrounded by Khanpur, Batapur and Guzhama villages on eastern, southern and north-western sides, respectively. Some part of the catchment is under paddy cultivation and willow plantation.

Trigamsar lake also is a shallow flat-land valley lake. It is a non-drainage type with no in or outflow channels. The main supply of water is through atmospheric precipitation and run-off from catchment and from springs within. The lake catchment comprising Karewa belt has a dense rural population on its eastern side. The northern catchment is rich in apple and almond orchards. Maize and pulses are cultivated on the western and southern sides of the catchment area which are partly used for cattle grazing.

The two lakes probably originated due to the formation of a depression in the Karewa floor which at a later stage got filled with water from springs which appeared in the basin[1]. The actual mechanism of depression formation is, however, not known.

3. Material and methods

The two lakes were surveyed in the month of October 1983 for various hydrographic and morphometric features. For the preparation of hydrographic maps, a baseline was chosen at the shore along the length of each lake. Alignment of the baseline was done by using ranging rods. The horizontal distance between various crosssections chosen at right angles to the base of the line was measured with the help of a measuring tape. The horizontal distance between various depth points on the crosssections was measured by using an inflexible graduated nylon rope across the width of the lake. The soundings of the lake bottom were taken with the help of a graduated inflexible nylon rope tied to a lead weight of 1 kg. The area surveyed was recorded in a field book to ascertain the horizontal distances and various depth (sounding) points of the lake. Subsequently from the field data, a contour (hydrographic) plan of each lake was plotted to a scale to form the bathymetric map.

Morphometric data of the two lakes was calculated after Welch[2] and Hutchinson[3]. Additional data on the catchment characteristics of the two lakes were obtained from the Department of Revenue, Government of Jammu and Kashmir.

4. Results

The bathymetric maps of Khanpursar and Trigamsar lakes are shown in Fig. 2 and the values of various morphometric features and catchment data are given in Tables I and II. The tables show that Khanpursar is a bigger and deeper water body, though both can be categorised as shallow non-mictic lakes. However, Khanpursar has a smaller catchment area (9·8 ha) as compared to Trigamsar (22·5 ha). Human population is also greater around Trigamsar (750 individuals) as compared to 300 individuals residing along the Khanpursar catchment.

The annual phosphorous and nitrogen load from the human wastes and agriculatural run-off to the lake waters is given in Table III. The quantity of phosphorous and nitrogen exported from the catchment area was calculated after Dillon and Kirchner[4]. A value of 23·2 mg $m^{-2}y^{-1}$ of phosphorous and $1g^{-2}y^{-1}$ of nitrogen input was used to calculate the total inputs of P and N into the lakes from their respective catchments. Maximum load of 0·11 kg of P and 1 kg of N per person has been applied as recommended by Enex[5]. This is 25% of the European standards.

Table I
Morphometric features of Khanpursar and Trigamsar

Lakes	*Area ($10^3 m^2$)*	*Max. length (m)*	*Max breadth*	*Mean breadth*	*Max. depth*	*Mean depth*	*Volume ($10^3 m^3$)*	*Shoreline length (m)*	*Shoreline develop-ment*
Khanpursar	126·32	450	300	280·8	4·0	2·09	264·4	1700	1·34
Trigamsar	109·76	700	200	156·8	2·6	0·76	83·49	2250	1·91

Table II
Some morphometric and catchment data of Khanpursar and Trigamsar

Lake	*Altitude (masl)*	*Lake area (h)*	*Area in water (h)*	*Area in marsh (h)*	*Load catch-ment area (h)*	*Area under agricul-ture (h)*	*Area under grazing (h)*	*Area under orchards (h)*	*Residen-tial area (h)*	*Human popula-tion of catch-ment*
Khanpursar	1580	6·8	5·8	1·0	9·8	2·8 (28·5%)	1·5 (15·3%)	5·0 (51%)	0·5 (5·1%)	300
Trigamsar	1580	6·0	6·0	–	22·5	6·5 (28·8%)	–	15 (66·6%)	1 0 (4·4%)	750

Figures in parenthesis are percentage of the total catchment.

Table III
Phosphorous and nitrogen load on the two lakes under investigation

	Khanpursar	*Trigamsar*
1. *Catchment*		
(i) P kg y^{-1}	2·4	5·6
(ii) N kg y^{-1}	103·0	215·0
2. *Human wastes*		
(i) P kg y^{-1}	33·0	82·5
(ii) N kg y^{-1}	300·0	750·0

5. Discussion

The study of the lakes reveals that the two lakes are small shallow water bodies and represent two types, outflow (Khanpursar) and closed (Trigamsar)[6]. The potential of delivery into the lakes was more to Trigamsar than to Khanpursar lake.

The two lakes have irregular basins as is indicated by the extent and development of their shoreline. The increasing irregularity in the form of embankments and projections of the shore are shown by the deviations from the value of 1. Khanpursar

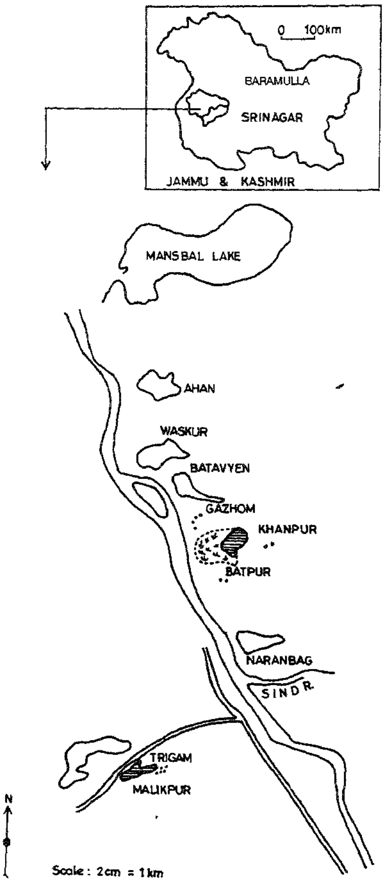

FIG. 1. Location map of the study lakes.

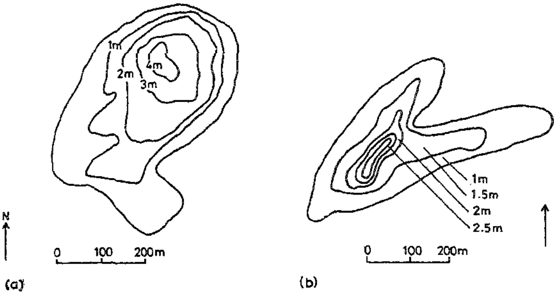

FIG. 2. Bathymetric maps of the study lakes: (a) Khanpursar (b) Trigamsar.

has a shoreline development value of 1·34 and Trigamsar has 1·91 indicating greater irregularity of the basin. Khanpursar has a nearly oval basin.

Both Khanpursar and Trigamsar have low depths. The maximum depth recorded in the two lakes was 4 and 2·5 m, respectively, with mean depths of 2·09 and 0·76 m. Sedimentation and siltation result in the filling of lake basins with ageing as a consequence of which depth and volume reduction takes place resulting in accelerated eutrophication[7,8]. The distance between the heterotrophic (recycling bottom layer) and productive layer (surface layer) is reduced due to reduction in volume and depth, further resulting in the increase and availability of plant nutrients per unit volume of the lake[9] and in eutrophy. Depth and slope are important features for differentiating lakes on the basis of trophic categories[10,11] . Lakes with deep and steep basins are usually oligotrophic whereas those having shallow basins and gentle slopes are eutrophic. Khanpursar and Trigamsar with shallow basins and gentle slopes fit the description of the latter category.

The type of land use determines the quantity of nutrients removed from the catchment and carried to the lake[12]. In the present study, the catchment areas can be described as agricultural catchment basins in which arable lands occupy over 70 per cent of the total area and meadows and compact buildings up to 10 per cent. The annual phosphorous and nitrogen load from human wastes and catchment areas to the lake waters (Table III) reveals that Trigamsar receives much higher input of these two nutrients in comparison to Khanpursar.

In the assessment of the effect of a catchment area on the cycling of water and matter in a lake, the important values to be considered are the indices relating to the surface area and volume of lake to the size of their catchment areas[13]. Table IV shows that Khanpursar shows a lower Ohle's Index (2·8) than that of Trigamsar (4·6) indicating that nutrient delivery from catchment area poses greater threat to Trigamsar than to Khanpursar.

Table IV
Calculation of Ohle's and Schindler's indices of the two lakes

Lake	*Catchment area (h)*	*Lake area (h)*	*Area of total lake basin × $10^3 m^2$*	*Lake volume × $10^3 m^3$*	*Ohle's Index*	*Schindler's Index*
Khanpursar	10·3	5·8	161	264·46	2·8	0·6
Trigamsar	21·5	6·0	275	83·49	4·6	3·3

Table IV shows a higher value of Schindler's Index for Trigamsar (3·3) as compared to Khanpursar (0·6), clearly indicating that Khanpursar can withstand a threat to its cleanliness from catchment whereas Trigamsar is very much dependent on the catchment as regards its water quality.

On the basis of the present study it may be concluded that the hydrographic features and catchment characteristics of Trigamsar make the lake more vulnerable to eutrophication as compared to Khanpursar.

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