

## **Bathymetric Maps of Lakes Phewa, Begnas and Rupa in Pokhara Valley, Nepal**

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**Abstract** A portable echosounder was used to collect data on construction of bathymetric maps of three lakes Phewa, Begnas and Rupa in Pokhara valley. Sounding transects were made so as to represent the whole lake area for data collection. The areas of the lakes Phewa, Begnas and Rupa were observed as 523 ha., 328 ha. and 135 ha. in order. The maximum depths of the three lakes were 24 m, 10 m and 6 m, respectively. The volumes and average depth of each lake were calculated. The surface areas, volumes and depths were increased after damming in both lakes Phewa and Begnas whereas the macrophytes were increasing tendency towards the swampy area and dense primarily at outlet side in Rupa.

### **INTRODUCTION**

Nepal is a small country covering an area 147, 181 km<sup>2</sup> only but has vast water surface area (about 400, 000 ha.) having more than 6, 000 rivers and streams measuring more than 21, 000 km (about 300, 000 ha.) in length (Shrestha, 1983). There are many lakes (5,000 ha.) and reservoirs (1,500 ha.) but very few work has been done on rivers, lakes and reservoirs. Few lakes (Phewa, Begnas and Rupa) in Pokhara valley and reservoir (Kulekhani) in sub-tropical region are being exploited for fish culture activities. There are other small lakes in Pokhara valley such as Khaste, Maidi and Deepang but they are becoming shallow every year and may convert into land later on. Lake Phewa is the biggest lake in Pokhara valley and very much popular for tourist point of view. Fish culture practice in cages has been going on since one and half decade in the lakes Phewa, Begnas and Rupa. Hickel (1973) was the first author to study on the three lakes and reported the maximum and average depths of the lakes. Later on, Ferro and Swar (1978) studied and constructed the bathymetric maps of the lakes Phewa, Begnas and Rupa.

This study was carried out after 14 years to maintain the recent information and to see the variation of lakes from the previous findings. This study was conducted in October, 1992 under the Natural Water Fishery Development Project with the entire guidance of

short term limnology expert Dr. Masami Nakanishi appointed from JICA (Japan International Cooperation Agency).

### MATERIALS AND METHODS

The old maps of lakes, used by Ferro and Swar (1978), were applied for this study too and the calculations were made on the basis of 1:17000 scale of photograph. Magnetic North was determined before starting the data collection and points were identified as



Figure 1. Lake Phewa showing sampling transects.

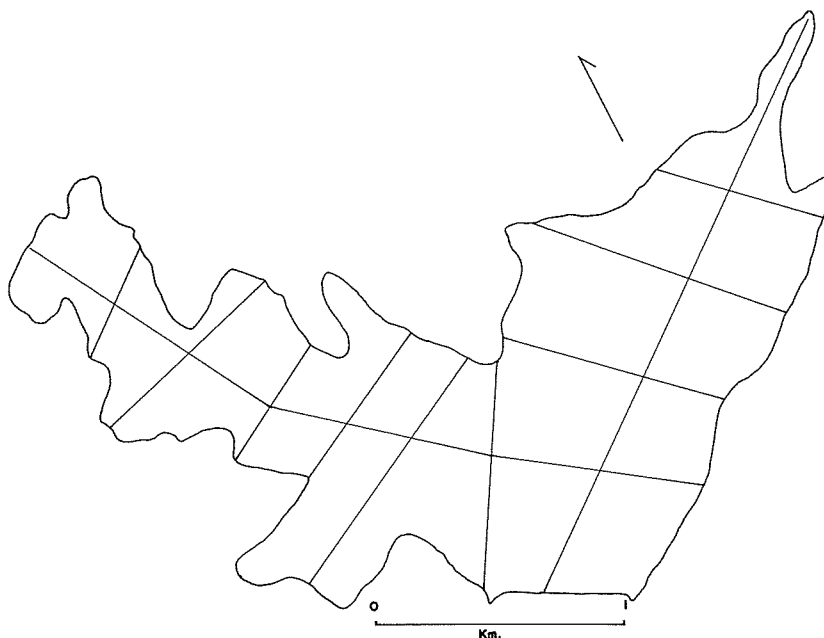
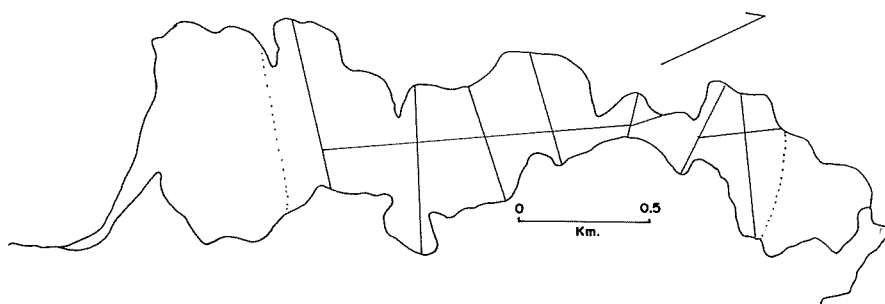


Figure 2. Lake Begnas showing sampling transects.



**Figure 3. Lake Rupa showing sampling transects.**

trees, hills and houses.

A portable selfrecording echosounder (HONDEX M-630) was used to measure the depths and stop watch for time record. The transducer was tied on the side of motorboat under water in lakes Phewa and Begnas whereas a dugout canoe was used in lake Rupa because of very shallow and having more macrophytes. A man was deputed to run the motorboat or canoe from one point on the shore to another and tried to maintain the constant speed. The data were observed based on each made on the map. In every transect, the echosounder chart was assumed as proportional record bottom profile.

Transects were chosen to represent the whole areas of lakes (Figs. 1, 2 & 3). Isobaths at 4 m intervals in Phewa, 2 m in Begnas and 1 m in Rupa were drawn on the maps. The area of the lakes and zones of different depths were computed by a computer. The precision and accuracy of echosounder were estimated as  $\pm 0.1$  m and 5 % respectively. The surface areas at each interval were measured with an Area Meter (LI-COR inc, LI-3100).

## RESULTS AND DISCUSSION

### *Lake Phewa:*

Phewa (742 m.s.l.) is the biggest lake in Pokhara valley and is fed by two perennial streams Harpan khola and Sedi khola but the water flow into the lake from these streams is not enough to fill-up the lake and collects water from 110 km<sup>2</sup> catchment area during monsoon. The shores are flat towards east and west. The depth increases gradually from north along south where the steep is very much (Fig. 4). The maximum depth was recorded 24 m at the south whereas Ferro and Swar (1978) reported the maximum depth was 19 m before 14 years. The surface area was recorded 523 ha. with the calculated volume  $393.3 \times 10^5 \text{m}^3$  and the average depth 7.5 m. The area covered more between 0 and 12 m depths and covered less area between 20 and 24 m with relatively more area between 12 and 20 m depths. Table 1 shows the area and volume at each depth zone.

### *Lake Begnas:*

Begnas (650 m.s.l.) is the second biggest lake in Pokhara valley and was dammed at the southern side in 1988. The area of the lake was 224 ha. (Ferro and Swar, 1978) before damming and after damming increased the area (328 ha.) and the depth (maximum depth:10 m ) with the increasing volume ( $179.6 \times 10^5 \text{m}^3$ ) (table 1). This lake is fed by

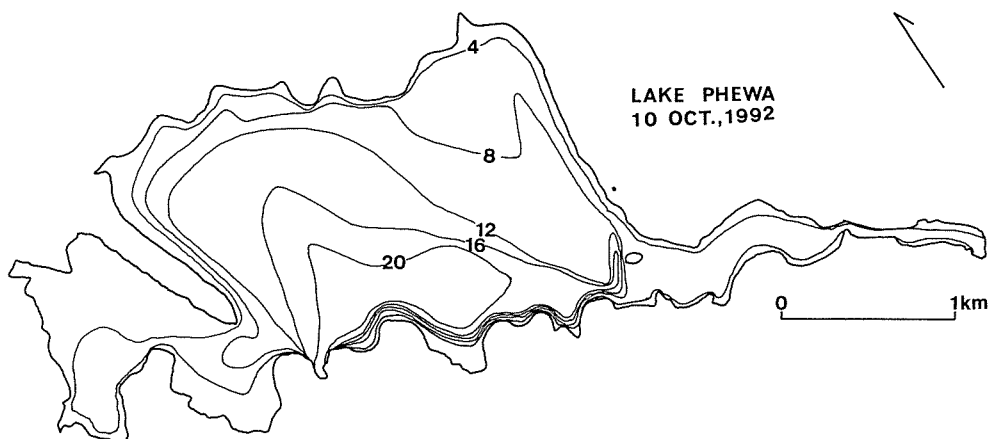


Figure 4. Lake Phewa showing depth intervals.

Table 1. Areas and volumes of lakes Phewa, Begnas and Rupa, Oct. 1992.

Depths (m)	<i>Lake Phewa</i> Areas (Ha.)	Volume (m <sup>3</sup> )
0 – 4	116.2	23.2 × 10 <sup>5</sup>
4 – 8	128.7	77.2 × 10 <sup>5</sup>
8 – 12	98.3	98.3 × 10 <sup>5</sup>
12 – 16	88.0	12.3 × 10 <sup>5</sup>
16 – 20	51.5	92.7 × 10 <sup>5</sup>
20 – 24	40.7	89.5 × 10 <sup>5</sup>
Total:	523.4	393.2 × 10 <sup>5</sup>
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<i>Lake Begnas</i>		
0 – 4	113.2	22.6 × 10 <sup>5</sup>
4 – 6	36.1	18.1 × 10 <sup>5</sup>
6 – 8	112.1	78.5 × 10 <sup>5</sup>
8 – 10	62.1	55.9 × 10 <sup>5</sup>
10	4.5	4.5 × 10 <sup>5</sup>
Total:	328.0	179.6 × 10 <sup>5</sup>
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<i>Lake Rupa</i>		
0 – 2	55.9	5.6 × 10 <sup>5</sup>
2 – 3	31.9	8.0 × 10 <sup>5</sup>
3 – 4	32.3	11.3 × 10 <sup>5</sup>
4 – 6	15.2	7.6 × 10 <sup>5</sup>
Total:	135.3	32.5 × 10 <sup>5</sup>

perennial stream Syankhudi khola and other tributaries but the lake is filled with water from 20 km<sup>2</sup> catchment area during rainy season. The deepest portion (10 m) was found towards the north-east side of the lake and found more shallow towards the outlet and inlet (Fig. 5). The average depth was 6.6 m.

**Lake Rupa:**

Rupa is the smallest lake among the three lakes and is situated at an elevation of 600 m.s.l. This lake is very shallow, elongated and narrow (Fig. 6). Talbishi khola is the main perennial stream which feeds the lake but the main source of water is rain fall during monsoon. The catchment area is 30 km<sup>2</sup>. The altitude is higher towards outlet having many paddy fields. Macrophytes are very common in this lake mainly at the side of outlet and increase towards swampy area. The surface area is 135 ha. with the maximum depth 6

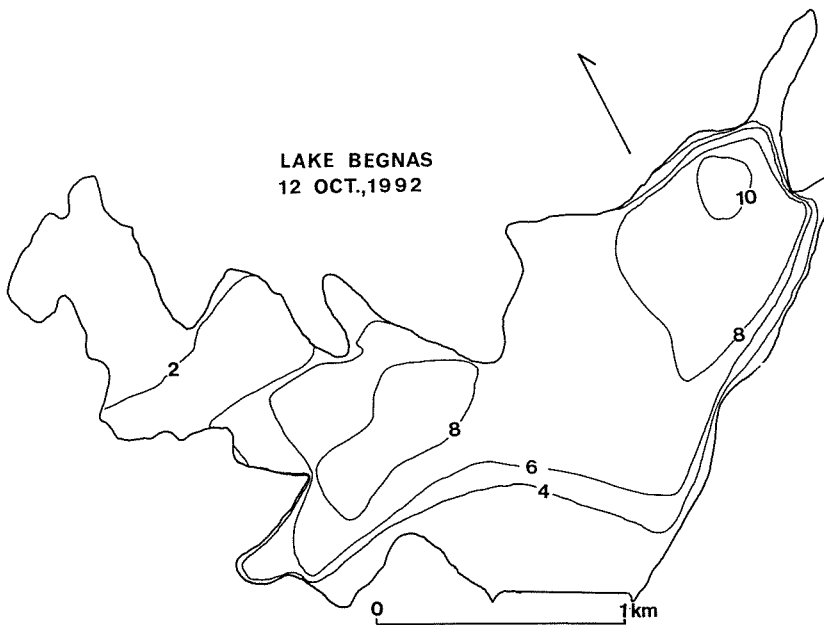


Figure 5. Lake Begnas showing depth intervals.

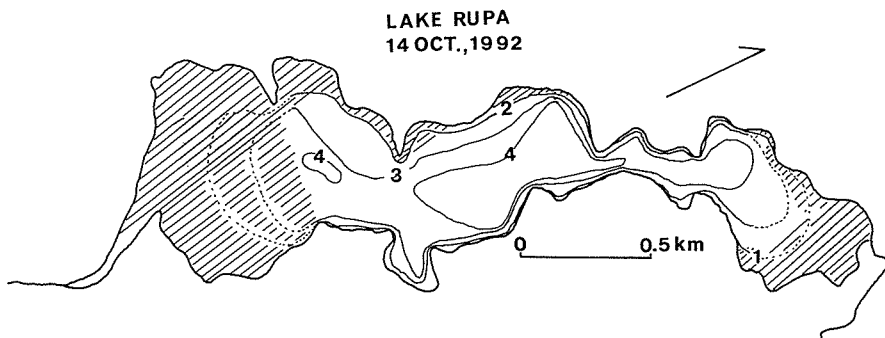


Figure 6. Lake Rupa showing depth intervals. Shaded area is macrophytes zone.

m and average depth 3 m. The area and volume at each depth isobath are shown in Table 1. The volume calculated was  $32.5 \times 10^5 \text{m}^3$ .

Lake Phewa is the biggest and deepest among three lakes and also showed peculiar bottom profile. Ferro and Swar (1978) surveyed after the dam was broken and reported the area 400 ha. with maximum depth 19 m. This study was done after damming and increased the depth (max. 24 m) as well as the surface area (523 ha.) which are reasonable. The soil structure of Pokhara valley is very peculiar and seems very loose soil which easily makes deep by the river. Therefore the deepest portion of the lake must be made by the river before damming and after dam was broken. Sedimentation is one of the big problems in this lake mainly near the inlet with north heavy siltation from Seti river. Sthapit and Leminen (1992) reported that the siltation is about  $100 \text{m}^3/\text{year}$  in lake Phewa and they estimated its existence as about 280–350 years.

Lake Begnas also was studied by Ferro and Swar (1978) before damming and they reported the maximum depth 7.5 m with surface area 244 ha. In the present study carried out after damming, Lake Begnas increased in its area and volume due to increase in the depth after damming and showed the maximum depth 10 m with the surface area 328 ha.

Lake Rupa also increased the area from 127 ha. (Ferro and Swar, 1978) to 135 ha. after about 14 years and this difference might be error for measurement due to many macrophytes in this lake. Anyway dense macrophytes were increasing towards swampy area and may convert into land in future unless dam will be made at outlet side. The outlets of Begnas and Rupa are relatively wide whereas the outlet of Phewa is narrow.

### ACKNOWLEDGEMENT

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