Bathymetry and Hydrobiology of Lake Mahagnao, Leyte

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Abstract

Lake Mahagnao in Burauen, Leyte (10° 52.15' N and 124° 51.32' E) lies 26 m above sea level. It is surrounded by a mountain range that includes a dormant twin volcano. A bathymetric survey established 122 sampling stations using Global Positioning System. The stations formed transect lines across the lake. A bathymetric map of Lake Mahagnao was generated with the use of the SURFER software. Lake Mahagnao has a shoreline of 15,590 m and surface area of 15.75 ha. The deepest portion of the lake is 18.75 m. The mean pH of the water is 6.58; water surface temperature, 27oC; and water visibility, 1.64 m. Eighty-one species were identified as primary producers. Station 5, the deepest portion of the lake, had the highest phytoplankton density at 4,716 cells/ml and Station 2 had only 634 cells/ml. Cyanobacteria were the most abundant in all the sampling stations.

Introduction

The Department of Agriculture's 'Gintong Ani' Program (GAP) for Fisheries was designed to enhance the productivity of the fishery resources within ecological limits. Lakes and riverine systems have been identified as priority areas under this program.

There were 59 lakes with a total surface area of 199,130 ha in the 1940 Census Atlas of Philippine Lakes, and 70 lakes listed in the Bravo Report. In 1980, the Bureau of Fisheries and Aquatic Resources (BFAR) reported 241 lakes from its compilation of provincial and regional data which included lakes less than 5 ha (Fellizar 1995).

In Eastern Visayas, there are four lakes and several inland bodies of water of various sizes. Among these lakes, only Lake Bito in McArthur, Leyte has a baseline information on hydrology (Francisco 1992). Considering the economic potential of Lake Mahagnao, limnological data are needed for proper management and conservation of the lake.

This paper describes the surface hydrology, topography, and the plankton diversity of Lake Mahagnao.

Materials and Methods

Before the survey, a courtesy call was made with the local government officials of Burauen. The survey was presented and discussed, the peace and order situation was determined from the police, secondary information on the lake was retrieved, and lakeshore residents were interviewed about the lake's history. All information were consolidated and the survey plans refined.

After an ocular survey, the route of sampling was plotted on the topographic map secured from the National Mapping and Resource Information Authority (NAMRIA). One hundred twenty-two sampling stations were established. Sampling stations cut diagonally across the lake in transect line fashion such that the entire lake area was covered (Fig. 1). At each station, pH was determined with a Jenway Electronic Digital pH meter (model 3150). Water transparency was measured with the use of a 26-cm diameter Secchi disk. Cloud cover was estimated by oktas (unit of measure for cloudiness representing 1/8 of the sky is covered by cloud). The specific bearing of the 122 sampling stations was determined with a Magellan Meridian Global Positioning System instrument.

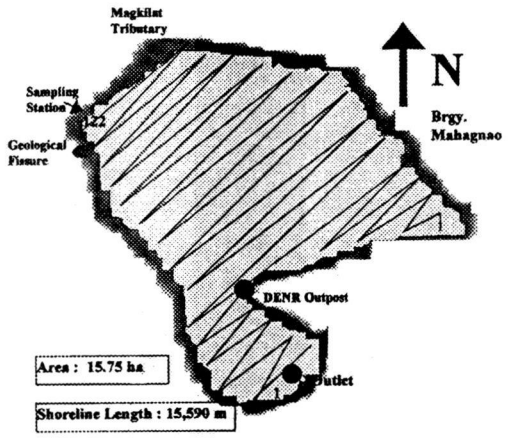

Fig. 1. Map of Lake Mahagnao

Two wooden dugout boats rented from the lake residents were used in the survey. The boats were joined side to side by a polyethylene rope to make them stable. To determine the bathymetry or the bottom topography of the lake, a polyethylene rope with a 2-kg lead sinker and calibrated at 1-m interval was dropped at each sampling station. A bathymetric map was generated with the Surfer software.

Plankton samples were collected from 9 sampling stations with a plankton net (0.3 m mouth diameter, 20 um mesh). The net was lowered at each sampling station at a speed of 1m/sec and towed obliquely at 0.75/sec. About 100 ml of the plankton sample as transferred to a polyethylene bottle and fixed with 5% formalin.

Plankton samples were examined in the laboratory with a compound microscope and quantified with a Sedgewick-Rafter counting cell. Phytoplankton species were identified using the taxonomic key of Needham and Needham (1976). Plankton density was calculated according to the method of Umaly and Cuvin (1988).

Results and Discussion

Lake topography and bathymetry

Lake Mahagnao (10° 52.15' N and 124° 51.32' E) is about 20 km west of Burauen poblacion and 26 meters above sea level. The lake has a length of 15,590 m and a surface area of about 16 ha. It receives water from Magkilat River tributary and pours its excess water at Awasan and finally at Guin-aniban Falls. A mountain range and a dormant twin volcano can be seen in the southwest. Grasses, ferns, coconut trees around the lake, and various timber species cover this mountain. The

flatlands are intensively planted to gabi, abaca, vegetables and various spices. Based on interviews, the catch from the lake includes tilapia, freshwater eel, carp, mudfish, snails, and freshwater shrimps.

Hydrology

Lake Mahagnao has a depth ranging from 0.5-19 m (Fig. 2), with no indication of siltation. Two steep depressions were found near the south shore and at the middle of the lake. A shallow portion (3 m deep) is located at the northern part of the lake.

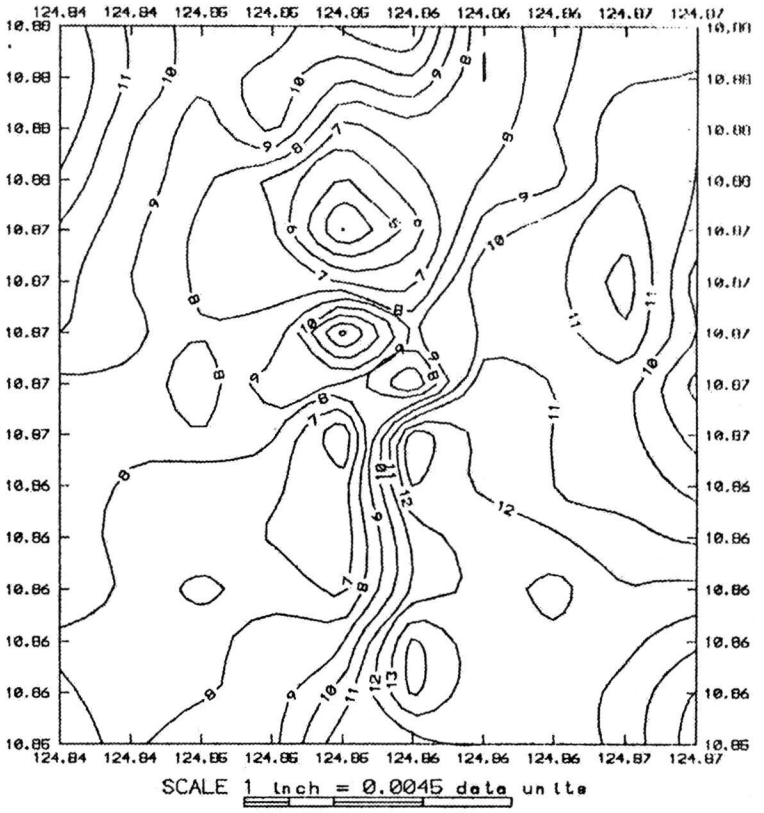

Fig. 2. Depth distribution in Lake Mahagnao

A bathymetric map of Lake Mahagnao is presented in Fig. 3. The bottom topography is very rugged, suggesting a volcanic origin. Lake pH ranged from 5.75-7.92 (Fig. 4) with a mean of 6.58. Secchi disk measurements ranged from 0.1-2.3 m (mean=1.64 m). Thus Lake Mahagnao is a clear lake.

Phytoplankton composition and density

A total of 81 algal species were identified as primary producers in Lake Mahagnao (Table 1). The phytoplankton was dominated by cyanobacteria (62%), followed by green algae (21%) and diatoms (16%). Other groups were in small numbers at the time of sampling. Station 5, the deepest portion of the lake, had the highest density of 4,716 cells/ml and station 2 had the lowest density of 867 cells/ml (Table 2). Cyanobacteria were the dominant group in all stations. The five most abundant species were: *Dactylococcopsis acicularis* (59%), *Synedra* sp. (15%), *Protococcus viridis* (9%), *Closterium* sp. (4%), and *Phormidium mucicola* (2%) (Table 3).

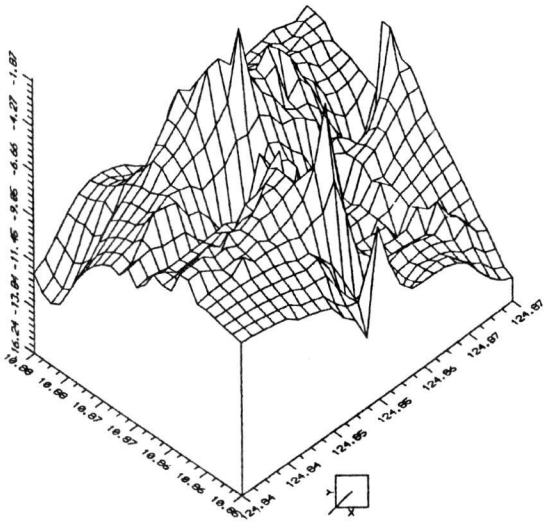

Fig. 3. Bathymetric map of Lake Mahagnao

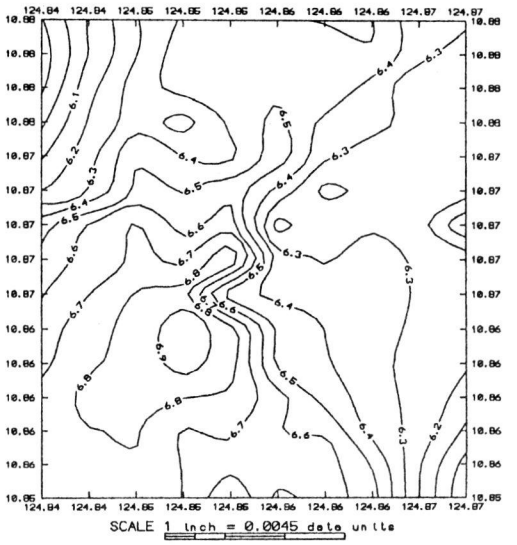

Fig. 4. pH distribution in Lake Mahagnao

The dominance of blue-green algae indicates that this lake is in its first stage of eutrophication. Zhang (1995) described eutrophication as the process of deterioration of the functions of water body due to increased nutrient loading to the lakes and consequently the enhanced growth of primary producers. The main components of primary producers in shallow lakes are phytoplankton and macrophyte competing for the same nutrients, light and other growth factors. Lake Mahagnao could be classified as a phytoplankton-type lake because of its dominance among the primary producers. No submerged macrophyte was observed. In general, the extent of eutrophication is more severe in phytoplankton-type lakes than in macrophyte-type lakes (Zhang 1995) because phytoplankton blooms, especially for blue-green algae, lower water transparency, deteriorate the water quality (color, odor), cause dissolved oxygen deficiency, and sometimes produce toxins.

Other factors that may have contributed to the lake condition are the narrow, man-made outlet (less than a meter in width) and the anthropogenic activities such as washing, bathing, and farming. Enclosed water bodies such as shallow lakes are more susceptible to eutrophication because of its low receptive capacity of organic load and the high residence time of the load. Consistent with the phytoplankton abundance is the annual fish kills experienced in the lake, a manifestation that there is an imbalance in the ecology of the lake.

Table 1. List of phytoplankton species by group in Lake Mahagnao, Burauen, Leyte

Cyanobacteria (Blue-green algae)		
Dactylococcopsis acicularis	*Spirulina major*	*Phormidium tenue*
Aphanothece stagnina	*Rhaphidiopsis curvata*	*Phormidium mucicola*
Eucapsis alpina	*Arthrospira jenneri*	*Nostoc linckia*
Coelosphaerium sp.	*Oscillatoria* sp.	*Calothrix fusca*
Merismopedia sp.	*Lyngbya limnetica*	
Chlorophyta (Green algae)		
Volvox sp.	*Ankistrodesmus falcatus*	*Cosmarium granatum*
Cosmarium sp.	*Apiocystis* sp.	*Uronema elongatum*
Chlamydomonas sp.	*Chlorococcum* sp.	*Spirogyra ionia*
Cosmocladium sp.	*Coelastrum reticulatum*	*Closterium* sp.
Chlamydomonas flascullariae	*Coelastrum sphaericum*	*Closterium strigosum*
Onychonema filiformis	*Coelastrum* sp.	*Closterium parrulum*
Chlamydomonas atactogana	*Closteriopsis longissima*	*Pleurotaenium* sp.
Gonatozygon aculeatum	*Selenastrum* sp.	*Straurastrum natator*
Chlamydomonas eherenbergii	*Treubaria crassispina*	*Straurastrum corniculatum*
Spirotaenia sp.	*Tetraedron minimum*	*Staurastrum quadragulare*
Chlorogonium elegans	*Tetraedron* sp.	*Euastrum oblongum*
Micrasterias torreyi	*Chlorella vulgaris*	*Euastrum pulchellum*
Chlorogonium peterhyiense	*Micratinium pusillum*	*Oocystis solitaria*
Pteromonas sp.	*Chodatella genevensis*	*Oocystis* sp.
Protococcus viridis	*Tetradesmus wisconsinense*	*Cosmarium obsoletum*
Echinosphaerella limnetica	*Franceia ovalis*	*Cosmarium punctulatum*
Chrysophyta (Yellow-green)		
Characiopsis cylindrica	*Ochromonas mutabilis*	
Chromulina pasheri	*Dinobyron setarin*	
Dinophyta (Dinoflagellates)	**Euglenophyta**	
Tetradinium sp.	*Astasia dangeardinis*	
Bacillariophyta (Diatoms)		
Cyclotella meneghiniana	*Synedra tabulata*	*Tabellaria fenestrata*
Cyclotella kuetzingiana	*Diatoma elongatum*	*Tabellaria* sp.
Asterionella sp.	*Amphora* sp.	*Nitzschia vermicularis*
Synedra sp.	*Eunotia* sp.	

Table 2. Phytoplankton composition and density by group (cells/ml) in different stations

Group/Taxa	Stn 1	Stn 2	Stn 3	Stn 4	Stn 5	Stn 6	Stn 7	Stn 8	Stn 9	Total
Cyanophyta	2321	634	1897	1735	2824	446	555	700	1033	12145
Chlorophyta	257	225	912	136	1868	54	220	303	96	4071
Bacillariophyta	8	0	1504	46	16	715	711	69	29	3098
Chrysophyta	0	0	0	65	8	11	28	14	0	126
Pyrrophyta	0	4	0	0	0	0	0	0	0	4
Euglenophyta	0	4	0	0	0	0	0	0	0	4
TOTAL	2586	867	4313	1982	4716	1226	1514	1086	1158	19448

Table 3. Densities of five most abundant phytoplankton species per station (Stn) in Lake Mahagnao (cells/ml)

Species	Stn 1	Stn 2	Stn 3	Stn 4	Stn 5	Stn 6	Stn 7	Stn 8	Stn 9	Total
Dactylococcopsis acicularis	2279	400	1843	1280	2808	435	541	700	1033	11319
Synædra sp.			1500	46	4	707	707	11	4	2979
Protococcus viridis					1818					1818
Closterium sp.	42		821							863
Phormidium mucicola				354						354
Other species	265	467	149	302	86	84	266	375	121	2115
TOTAL	2586	867	4313	1982	4716	1226	1514	1086	1158	19448

Conclusion

Lake Mahagnao in Burauen, Leyte has a slightly acidic water still suitable for aquaculture, recreation, and industrial use. The lake is eutrophic and its rugged topographical configuration indicates volcanic origin of the basin. Annual fish kill is a major problem in the lake.

Recommendations

The data gathered, analyzed and presented are not enough to draw a clear-cut view on the lake ecology because some of the variables were not measured. Thus, concrete management and conservation measures for the lake could not be laid out.

The team therefore suggests more comprehensive studies on:

- General water quality parameters such as thermal stratification, dissolved oxygen and pH levels, suspended solids and sediment analysis;
- Lake chemistry, specifically for sulfur, phosphorus and nitrogen;
- Productivity determination (primary productivity, chlorophyll a, zooplankton biomass and pollution determination such as coliform levels);
- Fish stock and fishing effort.

Since there are no endemic fishes in Lake Mahagnao, tilapia species may be stocked in the open waters. However, it is a general rule that introduction of species has to be done selectively because of the possibility of supplanting a native species through competition for nursery grounds or trophic niche (Darvain et al. 1984). Considering the rugged bottom topography of the lake and its depth, tilapia can also be cultured in net cages to augment fish production and income of the lakeshore residents. However, net cages should be regulated such that they do not exceed the carrying capacity of the lake.

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