TROPHIC STATE OF LAKE PETÉN ITZÁ, GUATEMALA

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INTRODUCTION

Lake Petén Itzá (16°54`00"N and 89°41´41" W) is located in lowlands of the Department of Petén at 110 m above sea level, within the Maya Biosphere Reserve. The Lake has an area of 100 Km^2 and 160 m maximum depth and its basin (1200 Km^2) is characterized by low-lying karsted limestones of Cretaceous and Tertiary age (Vinson, 1962) and classified as Tropical Wet Forest Bioma and Subtropical Wet Forest according to Holdridge Life Zones classification (Barrios, 1995). Petén region has overcame a demographical explosion since the 1960s, registering an increment in population from 25000 people to more than one-half million living nowadays in Petén. This has represented an important pressure on the ecological integrity of the ecosystems, which can be observed in Lake Petén Itzá basin. Forest loss, intensive agriculture, ranching and direct sewage discharges from the main towns in the basin (Flores, San Benito and Santa Elena), have increased the inputs of nutrients and pollutants to the lake leading to an increment in the lake eutrophication process.

OBJECTIVE

The aim of this study was to evaluate the water quality in Lake Petén Itzá in order to provide relevant information for making decisions related with water resources management and to improve the knowledge regarding the biogeochemical processes in the Lake.

EXPERIMENTAL

Water and sediments were sampled quarterly each year since 2004, in seventeen sites in Lake Petén Itzá (Table 1, Figure 1). Sampling sites were selected near towns and affluents, and three control sites in the center of the lake. Water analyses were made according to APHA-AWWA methodology (APHA, 1998). Metal in sediments were analyzed by Atomic Absorption Spectrophotometry (AAS). Toxic metals and organochlorine pesticides were analyzed in individuals of _Petenia splendida_ endemic fish.
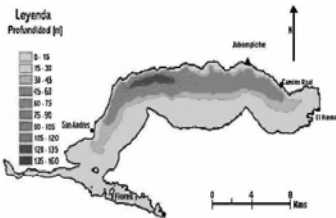

Figure 1. Sampling sites in Lake Petén Itzá. **Figure 2.** Digestion of sediments.

RESULTS AND DISCUSSION

Nutrients levels found in Lake Petén Itzá in this study correspond to eutrophic lakes, as can be seen in Table 1. $N-NO_3$ was found in mean concentrations above 500 $\mu g/L$ and $P-PO_4$ showed mean concentrations above 50 $\mu g/L$ especially in sites near towns and Ixlú River. This was confirmed by the presence of eutrophic and hypereutrophic phytoplankton organisms (cyanophytes, chlorophytes and diatoms).

Some pollutants found in Lake Petén Itzá, represent risks to the ecology and human health, as ammonia, which was found in high concentrations in sites near towns. High pH values shifts the equilibrium between ammonia and ammonium towards ammonia form, which is toxic for fish. Cr and Cd showed relatively high concentrations in sediments from the lake (Table 2), especially in Ixlú River, with high proportion of available form, indicating some risk for entering into the thropic chain by sediment resuspension. Individuals of the endemic fish species _Petenia splendida,_ analyzed in this study, showed levels of toxic metals (lead and mercury) and organochlorine pesticides (p,p´-DDT 0.7-1.2 ng/g; p,p´-DDE 5.4-20.2 ng/g and p,p´-DDD 0.8-1.9 ng/g). This should be taken in cosideration, as this fish is prepared in traditional dishes in Petén. Total and fecal coliforms, and _E. coli_ were found in all sampling sites.

Santa Elena, Flores, San Andrés, Jobompiche and El Remate showed the highest levels of contamination, with nutrients in concentrations corresponding to eutrophic levels

Table 1. Mean concentrations of main physicochemical water quality parameters in Lake Petén Itzá along the study.

Nr |	Sampling site	T (°C)	pH	$N-NO_3$ (mg/L)	$N-NH_4$ (µg/L)	$N-NO_2$ (µg/L)	$P-PO_4$ (mg/L)
1	Rio Ixlú	29.1	7.94	0.63	25	2	0.06
2	La Chingada	29.3	7.95	0.69	21	2	0.05
3	San Andrés	29.2	8.23	0.69	31	3	0.07
4	San José	29.3	8.23	0.69	27	2	0.06
5	San Pedro	29.4	8.12	0.70	18	2	0.08
6	Jobompiche	29.1	8.24	0.81	16	3	0.05
7	Cerro Cahuí	28.8	8.13	0.73	18	2	0.04
8	El Remate	28.8	8.00	0.78	25	3	0.05
9	Tres Naciones	28.9	8.11	0.61	41	2	0.05
10	South center	28.7	8.07	0.60	36	4	0.03
11	Lake center	29.0	8.20	0.71	25	1	0.04
12	West center	28.9	7.94	0.77	24	7	0.03
13	Le Pet	29.1	8.30	0.68	24	2	0.05
14	San Benito	28.8	8.28	0.65	36	2	0.05
15	Santa Elena	28.8	8.25	0.60	77	2	0.04
16	Aeropuerto	28.7	8.28	0.75	23	2	0.03
17	San Miguel	29.1	8.25	0.63	24	3	0.03

Table 2. Total and available mean concentrations of metals in sediments of Lake Petén Itzá (mg/g dw)

Metal|	Punta Nimá	Centro Sur	Tres Naciones	Río Ixlú	El Remate
Zn (A)	0.6	0.9	0.3	4.3	0.2
Zn (T)	5.1	14.8	74	22.9	13.3
Ni (A)	0.1	1.1	0.6	1.9	0.3
Ni (T)	3.5	10.1	5.4	8.8	7.3
Mn (A)	38.0	63.4	63.4	76.9	39.2
Mn (T)	672.3	1091.6	97.3	214.5	57.1
Cr (A)	4.8	4.6	6.5	7.9	8.3
Cr (T)	20.3	19.6	9.6	18.5	16.7
Pb (A)	2.2	5.1	1.6	6.4	1.3
Pb (T)	4.7	5.3	4.4	7.0	1.8
Cu (A)	0.01	0.11	0	0.22	0.01
Cu (T)	0.55	0.67	0.46	0.78	0.55
Cd (A)	0.05	1.3	0.4	2.5	0.2
Cd (T)	0.79	6.7	1.8	20.7	2.2
Fe (A)	48.4	236.8	16.5	251.2	20.5
Fe (T)	1920.2	8022.9	2492.9	12948.0	1677.4

A: available; T: Total.

CONCLUSION

The water quality in Lake Petén Itzá is not appropriate for human consumption nor for recreation. The metal concentrations found in sediments of Lake Petén Itzá are important as baseline, since industrial and commercial activities are increasing quickly in towns in the basin. It is expected that levels of nutrients in Lake Petén Itzá continue to increase as human population grows and while no seawage treatment be implemented in the towns surrounding the lake. Thus, it is important for government to make decisions regarding the installation of wastewater treatment plants in the short-term, especially in Santa Elena, San Benito and Flores.

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