MONITORING AND EVALUATION OF THE WATER QUALITY OF TAAL LAKE, TALISAY, BATANGAS, PHILIPPINES

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ABSTRACT

This paper presents an update on the physico-chemical properties of the Taal Lake for local government officials and representatives of non-government organizations by monitoring and evaluating a total of nine (9) water quality parameters. The study further shows that the Taal Lake's surface temperature, pH, total dissolved solids, total suspended solids, color, and dissolved oxygen content conform to the standards set by the Department of Environment and Natural resources (DENR); while phosphate, chlorine, and 5-Day 20°C BOD are below the standard. Likewise, the T-test result shows no significant difference in the overall average of the two sites at the Taal Lake (P > 0.05). Based on the data, the Lake is safe for primary contact recreation such as bathing, swimming and skin diving, and can be used for aqua culture purposes.

Key words: Cool dry season, hot dry season, rainy season, Taal Lake, water quality

INTRODUCTION

The health condition of every human being depends on the environment where he or she lives. With the unabated urbanization of localities due to increasing population, human and industrial activities and more so the extreme climatic condition, the supply of substantially healthy and fresh food in the market is affected. Sources of fish like lakes, seas, and rivers have been abused by man in exchange to industrial and domestic consumption. Non-conformance of businessmen, particularly those who rely on the supply of natural food such as fish pen and cage operators from water sources, to government imposed regulations make bodies of water more vulnerable to pollution.

The Philippines has a typical humid tropical climate. Average rainfall is approximately 2,026 millimeters per annum during rainy season from June to October (Lakenet, 2003). Its surface area covers about 234 square kilometers with an average depth of about 63 meters (Lakenet, 2003). The normal range of annual water level fluctuation of the Lake is 2 meters (Lakenet, 2003).

Despite the national government's declaration of the Taal Lake as protected area, number of illegal fish cages continue to increase. Approximately, there are 9,000 fish cages that contribute to its degradation (PCIJ, 2008). Likewise, some native fishes disappeared, the scenic view of the Lake is blocked, and its nature reserve put at risk.

The Taal Volcano Protected Landscape - Protected Areas Management Board (TVPL-PAMB) created the Unified Rules and Regulations for Fisheries (URRF). Its primary function is to care for the Lake. Likewise, it aims to identify specific areas to control the quantity of fish cages, prohibit destructive fishing methods, and implement existing rules in the preservation of the Lake.

URRF as a program is headed by the Department of Environment and Natural Resources (DENR) secretary Lito Atienza in coordination with the Batangas Governor, Vilma Santos-Recto. They are assisted by the other local government officials in limiting the number of fish cages. The uncontrollable proliferation of these cages is due to the fact that fishing is the primary livelihood of the locales, and the high demand of aquatic food products in the CALABARZON and Metro Manila areas. Be it that, the existing problem on the profuse number of cages in the Lake might have already been difficult to address at the present as the problem started even during the early or first phase of the program implementation.

METHODOLOGY

Study Site

Taal Lake, formerly known as *Bombon Lake,* is the deepest and the third largest Lake in the Philippines. It is located between 14.002°N to 14°0'6"N latitude and 120.993°E to 120°59'36"E longitude (Lakenet, 2003). The Lake was declared as protected area in 1996 through the Administrative Order No. 118. The stretch of the Lake covers the municipalities of Talisay, Malvar, Tanauan, Laurel, Agoncillo, Sta. Teresita, Cuenca, Alitagtag, Mataas na Kahoy, Lipa City, Balete, and San Nicolas in Batangas. Thirty-seven (37) tributaries drain into the Lake and its only outlet is the Pansipit River. It drains to Balayan Bay and it serves as the entry and exit points for migratory fish (Asian Development Bank, 2003).

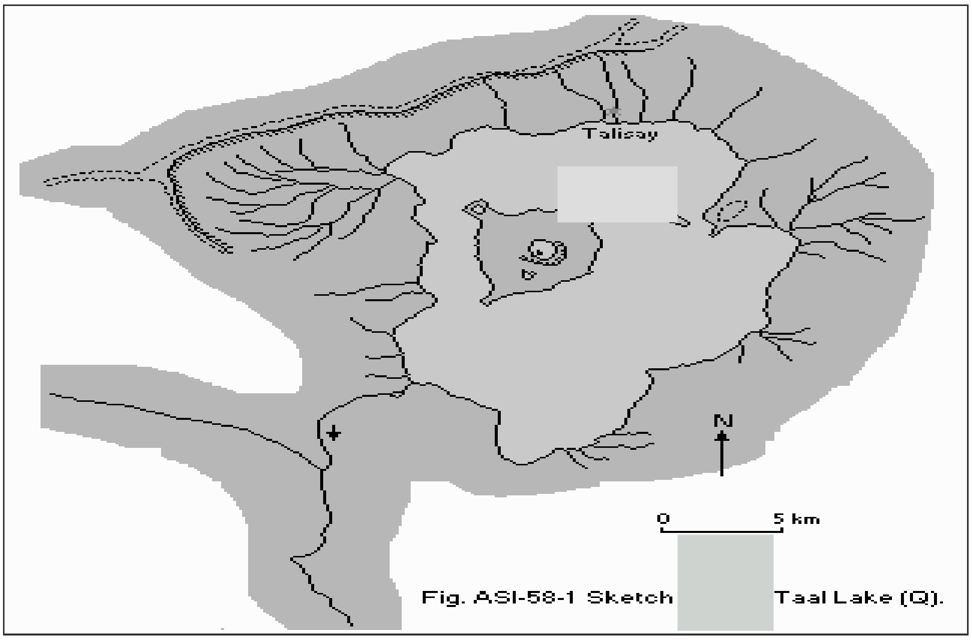

Figure 1. Map of Taal Lake

Water Sampling

Water sampling was done *in situ* to determine the quality of water of Taal Lake in Talisay, Batangas. Samples were collected from the two sampling sites referred to as Site 1 (with fish cages) and Site 2 (without fish cages). Each site was divided into two layers. The first layer is referred to as Layer 1: The surface layer. The second layer is referred to as Layer 2, 10.5 feet: The layer below water visibility. The latter was marked through the use of Secchi disk. Likewise, the collection of samples was conducted quarterly within a year. To determine whether there were differences in the results at different times of the day, sampling was done at two sampling intervals: early morning around 9:00 A.M. and late afternoon around 2:00 P.M.

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For the chemical and physical analyses, approximately 1000 mL of water sample per sampling site was collected. Then, the samples collected were placed in an ice cooler and transported immediately to the laboratory for analysis.

Physico-chemical Analysis

Water temperature was measured *in situ* using a handheld thermometer. Likewise, other parameters like chloride and phosphate were analyzed in the laboratory.

In the Biochemical Oxygen Demand (BOD) test, the direct determination method is used wherein standard 300-mL glass BOD bottles were used. Two Dissolved Oxygen (DO) measurements were involved in the 5-day 20ºC BOD of the water samples. The initial measurement began at t = 0 and the second measurement at t = 5 after the sample has been incubated in the dark for five days at 20ºC. The BOD marks the difference between the two measurements. To determine the BOD of the water sample Dilution Technique was used.

To determine the Dissolved Oxygen (DO) concentration, a membrane electrode meter was used after conducting a careful water sampling. The use of the electrode probe was material in the process as it senses small electric currents that are relative to the dissolved oxygen in the water.

Gravimetric Method was used to determine the Total Suspended Solids (TSS). A 100mL water sample was filtered using a glass fiber filter paper. Then, the water sample was set to evaporate into dryness from 103ºC to 105ºC using a pre – weighed 100mL beaker. After evaporation, the beakers, which hold the sampling, were placed in desiccators before weighing. The cycle of drying, cooling, desiccating, and weighing was continued until a constant weight was obtained or until the weight discrepancy among the samples was less than 4% of their previous weight or 0.5mg, whichever is lower.

The Total Dissolved Solids (TDS) were also determined using TDS meter. In TDS meter, a probe that contains temperature sensor senses the TDS value. It also automatically adjusts the temperature difference. The measurement is completed after the reading had stabilized.

Chloride was determined using argentometric method. In this process silver chloride was quantitatively precipitated before the formation of the red silver chromate. Likewise, calculation was done after the experimentation.

In phosphate analysis, the pH of the sample was adjusted to fall within the range of 4 to 10 by dilution if extremely acidic and by addition of phenolphthalein if extremely basic. The highly colored samples were passed through activated carbon. Likewise, the test sample was placed in a volumetric flask which was added with vanadate-molybdate reagent. Moving on, distilled water was used to dilute the solution to mark. After several minutes from the time of adding the vanadate-molybdate reagent, the absorbance of the sample versus the blank at a wavelength of 400-490 nm was measured. A calibration curve by using suitable volumes of standard phosphate solution was also prepared and read at the same wavelength.

ANALYSIS OF DATA

The gathered data were clustered according to layer, site, and into three seasonal variations namely: rainy (from June to November), Cool dry (from December to February), and Hot dry season (from March to May). This procedure was done after determining the physical and the chemical characteristics of the water samples. To test if there was a significant difference in the characteristics of water of Taal Lake based on the selected sampling sites, the T – test was used. Hence, the average mean for the whole year was calculated since there is no significant difference in terms of values per site, layer, and season. The results were compared against the standard set by Department of

Environment and Natural Resources – Environmental Management Bureau (DENR-EMB, Administrative Order no. 34, 1990).

RESULTS AND DISCUSSION

The results of the study were compared against the standard set by DENR-EMB. Table 1 shows the total mean of physical and chemical characteristics of Taal Lake in site 1 and site 2 for the whole year as compared to the standards set by DENR-EMB.

Table 1. Results of the physical and the chemical characteristics of Taal Lake at Talisay, Batangas for the whole year; Values shown are total mean and standard limits set by DENR-EMB for surface waters (AO No. 34, 1990)

Parameters	Site 1	Site 2	Mean Values	Standard Set by DENR-EMB (for Class B)	Interpretation
Water temperature (°C rise)	26.42	25.87	26.15	3*	Within the standard
Color	No abnormal discoloration from unnatural causes	No abnormal discoloration from unnatural causes	No abnormal discoloration from unnatural causes	No abnormal discoloration from unnatural causes	Within the standard
pH	8.27	8.35	8.31	6.5 – 8.5	Within the standard
Total Dissolved Solids (TDS, mg/L)	914.33	911.58	912.96	1000 mg/L	Within the standard
Total Suspended Solids (TSS, mg/L)	5.33	5.00	5.17	Not more than 30% increase	Within the standard
Chloride as Cl (mg/L)	577.24	575.47	576.36	250 mg/L	Exceed the standard
Phosphate as Phosphorus (mg/L)	0.21	0.21	0.21	0.2	Exceed the standard
5-Day 20°C BOD (mg/L)	3.08	3.42	3.25	5 (minimum) 10(maximum)	Below the standard
Dissolved Oxygen (DO) (mg/L)	6.92	8.67	7.79	5(minimum)	Within the standard

* The allowable temperature increase over the ambient temperature is 3°C

Increase in water temperature results in greater natural activity while its decrease results in increase in dissolved oxygen (Johnson, 2000). If the water tended to get warm, its nutrients mixed uniformly as oxygen is restored. This oxygen is used by microorganisms and results in the reduction of the amount of dissolved oxygen.

Stable water temperatures were observed at Taal Lake during the 12-month period of monitoring. The average recorded temperature is 26.15ºC. The increase in temperature during Hot Dry Season is minimal and conforms to the standard set by DENR-EMB since there has not been a recorded increase of more than 3ºC compared with the ambient temperature. In general, the increase in temperature in the Taal Lake for the whole year did not affect its situation since no irregularities have been monitored like degrading of environment.

pH signifies the acidity or alkalinity of the matter being tested. Average pH level is extremely significant to the health of aquatic life. Low pH level may cause death to many fishes in rivers and lakes because some aquatic organisms are sensitive to changes in pH and a few of them may not be able to endure the changes. Low pH can also raise the quantity of heavy metals such as aluminum and mercury (Lusch, 1997). For example, a pH of 4 or less of water cannot be tolerated by a marine organism in a river.

In Taal Lake, a negligible change in pH was monitored with an average value of 8.31. This value conforms to the standard set by DENR-EMB.

The rising water temperature is directly correlated to total dissolved or suspended solids (TSS and TDS). An increase in the amount of TDS and TSS can increase the temperature of water since floating materials absorb heat from sunlight. These two parameters can also reduce the color of the water and can influence photosynthesis (IWR-MSU, 1997).

Taal Lake has a mean of 912.96 mg/L and 5.17 mg/L of total dissolved solids (TDS) and total suspended solids (TSS), respectively, for the whole year. The value of TDS is very close to the standard set by DENR-EMB which is 1000mg/L but still conforms to the standard. TSS also conforms to the standard set because not more than 30% increase in the amount was monitored. The amounts of these parameters are possible because of the accumulated lava from the volcano or maybe from the feeds given to fishes and other activities such as bathing and fishing.

Chloride is damaging and killing some parts of the body each time one bathes or swims in the river (Bordin, 2007). High chloride content can also cause poisoning of aquatic organisms similar to the study of Moskovchenko, Babushkin, and Artamonova (2008) on the Vatinsky Egan River catchment in West Siberia. The results of the said study shows that the river has wide and high concentration of chloride.

These findings in the study on the Vatinsky Egan River is comparable to this study on the Taal Lake because 576.36 mg/L Chloride was recorded during the entire period of monitoring. This value does not conform to the standard set by DENR-EMB which is 250mg/L. The high amount of this chloride is maybe due to the thirty-seven (37) tributaries that drain into the Lake for years. This is quite alarming because high chloride content can cause poisoning of aquatic organisms.

Higher phosphate content in the Lake can be dangerous to marine organisms. It can cause tremendous development on aquatic bloom that may lessen the quantity of light in the water and decrease the amount of dissolved oxygen. Eutrophication causes algae growth; the decay of this bloom will deprive fish of sufficient oxygen (Bodzin, 2004).

In Taal Lake, Phosphorus has an average value of 0.21 mg/L. Based on the data, the study shows that Taal Lake has a little higher phosphate content as compared to the DENR-EMB standard of 0.2 mg/L. This condition is anticipated since heavy rainfall increases the downpour of domestic wastes containing detergents and top soils carrying naturally occurring phosphorus from the neighboring highlands (Helmer and Hespanhal, 1997).

Biochemical oxygen demand (BOD) determines how a huge quantity of oxygen is used by aquatic life in the aerobic oxidation. The BOD presence in the Lake can be attributed to the increase of discharges into the lake such as polluted topsoils and other household wastes transported by heavy precipitation from the nearby residential area. However, in Taal Lake, below the minimum standards set by DENR-EMB was monitored with a value of 3.25 mg/L.

Dissolved oxygen (DO) is necessary for the survival of aquatic organisms. It is the amount of oxygen dissolved in the bodies of water. Low DO readings show high oxygen requirement of aquatic organisms. This is maybe due to severe pollution.

During rainy season the Dissolved Oxygen (DO) in Taal Lake has a value of 3.75 mg/L. The value does not conform to the standard set by DENR-EMB. However, the average value of 7.79 mg/L for the whole year is within the standard. The fluctuation of dissolved oxygen in Taal Lake could be the possible reason for the profuse occurrences of fish kills.

Color is produced by particulate substance in water. TDS and TSS can also affect the color of water. In the case of Taal Lake, no abnormal discoloration (changes color of water to light brown or more intense light brown) due to unnatural causes was observed during the whole year of monitoring. It means that color conforms to the standard set by DENR-EMB.

Tale 2 shows the t – test result of site 1 and site 2 for equality of means. The result shows that there is no significant difference in the overall average of the two sites at Taal Lake since the t-value of 0.006 has a p-value (0.996) greater than 0.05.

Table 2. Results of t- test for equality of means for Site 1 and Site 2

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	.000	.995	.006	20	.996	1.38818	249.92191	-519.93979	522.71615
Equal variances not assumed			.006	20.00	.996	1.38818	249.92191	-519.93995	522.71632

To preserve the quality of water in Taal Lake, safety, security, and environmental management plan must be implemented by concerned local government units (LGUs). This way the best beneficial use of the Lake is likely to be sustained. Likewise, information campaign on the protection and preservation of the Lake has to reach nearby residents and mountaineers to mitigate the quantity of contaminants in the vicinity.

Based on the overall results of the study, Taal Lake water can still be classified as Class B (DENR-EMB, 2005), Recreational Water Class I. The classification is the same with Pagsanjan river of Laguna and the Bolbok river of Batangas (DENR-EMB, 2005). In general, the Lake can be beneficially used for primary contact recreation such as bathing, swimming, and skin diving.

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