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Assessment of Physicochemical Parameters in Selected Water Bodies in Laguna, Philippines

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Abstract: - This study was aimed to examine the frequent variations in four selected physico-chemical parameters of surface water of two lakes in Laguna: Laguna de Bay in Calamba City and Sampaloc Lake in San Pablo City. Parameters such as conductivity, dissolved oxygen (DO), pH, and temperature were determined using in-situ water quality tester. The two lakes are both freshwater body, different data are collected and observed throughout the sampling. Due to various anthropogenic activities, the lakes are biotically affected. The water quality of the two important lakes in Laguna have been compared in different parameters like pH, DO, conductivity, water temperature and color. The result indicates that both lakes are within the standard (25-31°C) of DENR Administrative Order (DAO 2016-08 for Class C), but except for water temperature which exceeds the standard value (36.37°C mean values). The results support insights about the future effects of increased water temperature on fish management and the lake ecosystem for numerous aquatic purposes. This is also for the management and call on action for the residents and local government unit in said municipalities of Laguna especially after pandemic season.

Keywords: conductivity, DO, lakes, pH, water temperature

I. INTRODUCTION

Geographically, world is composed of water that takes up more space with about 75% than the land. In that 75%, only three percent is considered as a freshwater while 97% is saltwater or marine water. Water pollution has become a significant and increasing threat to both freshwater and marine ecosystem as well as in public health. Water is one of the most essential things in life; it is needed by all living things for them to survive. According to [1], the quality of water is depreciated due to pollution, and it is one major concern of environmentalists [2]. Also, water quality mainly affected by geological processes such as weathering and erosion; and anthropogenetic inputs caused by human activities from municipal, households and industrial waste.

Aside from natural processes and anthropogenic inputs, there are also waterborne organisms which are bacterial pathogens (*Vibrio cholera*, *Salmonella typhi*, *Pseudomonas* and others) and aquatic parasites (*Giardia*, *Amoeba*, *Cryptosporidium* and the like). These pollutants can be associated to human diseases such as leptospirosis, typhoid, diarrhea, amoebiasis, and the like. Human population suffers from different diseases due to use of contaminated water It is therefore necessary to check the water quality. According to [3], a good quality of water is vital not only to avoid any kind of diseases but also to improve and protect the quality of life. Lake ecosystems are made up of physical, chemical, and biological properties contained within these water bodies. It is also an inland body of water that lacks any direct exchange with the ocean [4]. It has long been at the center of human attention. Toxic wastewater, surface water runoffs from municipal, industrial, and agricultural sources from the increasing population growth and industrial activities at the same time have increase pollution load and freshwater is affected [1,5,6].

Since increasing water pollution can be a threat to aquatic ecosystem, monitoring and evaluation of water quality are needed. A serious world problem because of the different pollutants (physical, chemical, and biological) water sources have been contaminated which become the reason of water [7]. The paucity of information on the water quality of some freshwater lakes in the country encouraged the authors of this study to undertake this kind of investigation. It is, therefore, crucial to thoroughly observe the quality of water and its numerous uses. The present study was aimed at assessing the values of physicochemical selected parameters natural freshwater bodies in two essential lakes of Laguna.

II. MATERIALS AND METHODS

A. Sampling locations

The study was conducted at the two lakes in Laguna which are in the Laguna de Bay-Calamba, Laguna and Sampaloc Lake in San Pablo, Laguna. Laguna De Bay is one of the most significant inland bodies of water and the biggest lake in the Philippines. South Bay part with an average depth of only 2.5 meters where Calamba City, Laguna is located. It was also estimated that the lake's water holding capacity is 2.19 billion cubic meters and lastly is its watershed area which straddles the whole provinces of Rizal and Laguna with 3,820 square kilometers.

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Sampaloc Lake on the other hand, it is one of the seven crater lakes of San Pablo Laguna. It is the largest and premier lake of San Pablo. Aquaculture development in Sampaloc Lake has rapidly increased, through the years. Fish culture in floating cages has become a very popular and profitable business.

The locations were selected based on current surrounding conditions considering the population and activities (Figure 1).

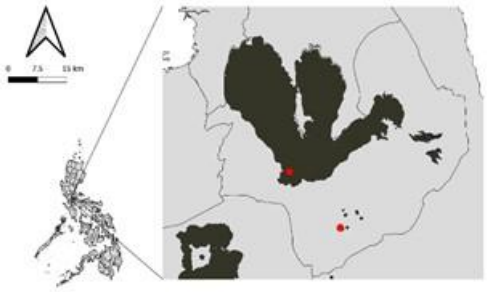

Figure 1. Geographic location of the study area in red dots color: Laguna de Bay in Calamba City, Laguna and Sampaloc Lake in San Pablo City, Laguna, Philippines.

B. Water Quality Testing

Temperature (˚C), pH, dissolved oxygen (DO), and conductivity (µS/cm) were measured with the Aquaread Probe Meter water quality checker. All results obtained from the physicochemical parameters were compared to DENR (Order No. 2016-08) standards, except conductivity (WHO).

C. Statistical Treatment of Data

Mean was used in analyzing the physicochemical parameters in both lakes of this study. To compare the two lakes in terms of four physicochemical parameters, the T-test was used.

III. RESULTS

The physicochemical attributes that were examined in water is offered in Table 1. Table 1 shows the physicochemical factors that were assessed in the two lakes, while Figure 2 shows individual parameters measured in months. The parameters were compared with DENR-EMB (DA) 2016-08) standards for water. The conductivity values ranged from 208.43mS/m (Sampaloc Lake) - 379.28 mS/m (Laguna de Bay). Dissolved Oxygen (DO) values ranged from 4.09mg/L (Sampaloc Lake) - 7.55mg/L (Laguna de Bay). The pH of the lake water samples ranged between 5.48 (Sampaloc Lake) - 6.04 (Laguna de Bay). The temperature ranged from 36.30°C (Laguna de Bay) - 36.44°C (Sampaloc Lake).

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Table 1. Physicochemical parameters in two lakes: Laguna de Bay and Sampaloc Lake.

Parameters	Laguna Lake	Sampaloc Lake	Mean value	Standard Value	Interpretation
Color	Brown	Greenish	n/a	n/a	
Conductivity(ms/m)	379.28	208.43	293.855	No data	
Dissolved Oxygen (mg/L)	7.55	4.09	5.82	5 (minimum)	Within the standard
pH	6.04	5.48	5.76	6.5-9.0	Within the standard
Temperature (°C)	36.30	36.44	36.37	25-31	Exceeds the standard value

*Standard Value by DENR-EMB (DAO 2016-08 – for Class C)

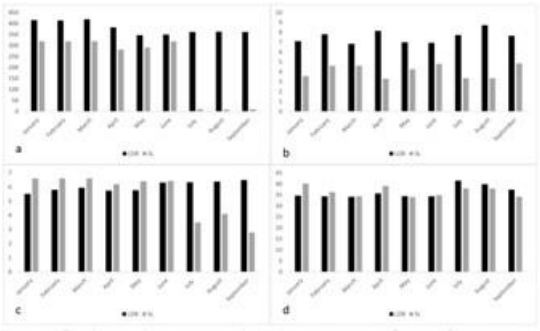

Figure 2. Physicochemical parameters in two lakes: Laguna de Bay and Sampaloc Lake. (a) conductivity; (b) DO; (c) pH; and (d) temperature.

IV. DISCUSSION

One of the best indicators used in determining water quality are water physicochemical parameters. The physico-chemical parameters analyzed in this study were electrical conductivity, dissolved oxygen, pH, and temperature.

In determining the quality of water, the ability of water to allow the flow of electric current is measured by its electrical conductivity. The ion concentration in water determines the conductivity. These ions come from the dissolved salts and inorganic elements. In the two sampling locations, this is clearly showed that the last three months (July-September) in Sampaloc Lake became the lowest among the other samples. On the other hand, the Laguna de Bay's values are still high and almost consistent. There was a dramatic drop in conductivity as shown is Figure 2.a. According to the [8], the permissible limit for conductivity is 300 μS/cm. Average conductivity values across all months in two locations are exceeded in acceptable limit except for the Laguna de Bay in the months of April and May; and in Sampaloc Lake during July-Septermber. High quantities of cations and anions may alter the chemical composition of the aquatic system. This indicated that water contamination is visible by a high conductivity value [9]. It is also recognized by the report of [10] who recorded remarkable increase in conductivity between the months of January-March. Rainfall, and temperature, are some of the factors that affect conductivity in water. Between the periods of April-June, rainfall increased drastically, and reduction in industrial activities could also be a reason for the decrease of conductivity in these months.

Dissolved oxygen (DO) refers to the amount of oxygen gas present in a water body (Figure 2.b). All types of life, including species accountable for self-refining mechanisms in aquatic ecosystems, require oxygen [11]. DO concentrations in August (Laguna de Bay) 8.72 mg/L was values of DENR-EMB, and the WHO permissible level for DO is 5 mg/L. Most concentrations across months were higher in Laguna de Bay. DO levels in water signifies the physical and biological results that endure in water and is usually affected by aquatic plants and plankton concentration, aside from temperature and organic matter [12]. According [13], salinity and temperature are inversely proportional to oxygen solubility in water. Temperature, salinity, turbulence, algae, and plant photosynthetic action, and atmospheric conditions all affect oxygen levels.

pH is a substantial factor as it has an impact on a diversity of biological and chemical processes in waterways (Figure 2.c). It is a process of determining acidity or alkalinity, as well as the sum of hydrogen ions in water. The pH values may vary due to the existence of some pollutants, like oxides of sulphur and nitrogen which are converted to nitric and sulphuric acids, especially when calculated and documented continuously, together with the electrical conductivity of a water body [14]. A pH range of 6.5 - 8.5 is permissible according to the [15]. The pH of water as presented in Table 1 and Figure 2 falls within acceptable limits, but there are some which is lower than the standard values of DENR-EMB, particularly in Sampaloc Lake which is 5.48 in Table 1. However, pH levels across Sampaloc Lake in June are higher than in July, August, and September. This is likely due to a decrease in rainfall during the period. The pH value varied from 2.79 to 4.10 in July-September and 5.52 to 5.78 in January-June in Sampaloc Lake. Minor changes in pH may result in prolonged effects; the solubility of phosphorus and other nutrients can be enhanced by altering the pH of water [16]. The increasing in demand for DO is based on the more the nutrients, and the more aquatic plants and algae thrive [17].

According to [18], water temperature is a vital parameter in the study, it influences the living species such as the aquatic plants and animals' growth and the biological demand for oxygen in lakes. Basically, as water temperature increases, it holds less oxygen. Also, due to increased respiration, flora and fauna use more oxygen. These factors normally result in less available oxygen for fish in water. Also, supported by the results of [18], the examined water temperature in this study is higher compared to the standard value set by the following criteria – DAO 2016-08: 25-31˚C, [19]: <35˚C, and desirable limit [20] 20-30˚C. On the other hand, according to [21] prefers a temperature between 31–36 °C as a suitable temperature for fish farming, [22] recommends a water temperature ranging between 25 to 32 °C. The result of the present study reads a temperature ranging from 34.0–41.5 °C and is alarming compared from the previous findings.

V. CONCLUSION

Based on the results attained, all the sample in two locations and different months, though subjected to varying levels of pollution, still has the tendency and ability to sustain aquatic life and the ecosystem. Of the two sampling locations, the samples obtained from Laguna de Bay seem to have the better quality in terms of the parameters than with Sampaloc Lake. In-spite of these issues, the water bodies have managed to sustain the ecosystem and most aquatic life. The presence of aquatic plants that take in some of these pollutants and release oxygen may also help improve quality. People in the area near the lakes should be trained to improve best practices on fish managing fish pens in the lakes, to reduce organic load and waste accumulation these will guarantee that some of the parameters in this study will not exceed levels that could be harmful to fish in the aquatic environment.

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