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Assessment of the Water Quality of Mamba River of Mts. Palaypalay/Mataas na Gulod, Southern Luzon, Philippines

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Abstract. The study focused on the assessment of the water quality of Mamba River at Mts. Palaypalay/Mataas na Gulod National Park, Southern Luzon, Philippines. It aimed to determine the physico-chemical properties of the river to provide a baseline data and suggest beneficial use for the river. A total of nine (9) water quality parameters were monitored and analyzed once a month for twelve (12) months. The study showed that the Mamba River's surface temperature, pH, total dissolved solids, total suspended solids, 5-Day 20°C BOD, chlorine, and dissolved oxygen content conform to the standards set by the DENR while color and phosphate are below the standard. Based on the data gathered, the river can be best used for primary contact recreation such as bathing, swimming, and skin diving. The river can also be developed for aquaculture purposes, and it is suitable for fish propagation and growth.

Keywords: Mamba River, cool dry season, hot dry season, rainy season, water quality

1. Introduction

Man depends upon inland waters, especially fresh water, for domestic and industrial use. With increasing population, the supply of safe drinking water is at risk.(Mijares, 2004). The abuse of rivers and lakes through domestic and industrial disposal and indiscriminate conversions of fresh surface waters into ecotourism sites deprive the population of more essential uses of fresh waters.

Mts. Palaypalay/Mataas na Gulod National Park is near Metro Manila and within the CALABARZON region, and is very vulnerable to commercialization and industrialization. As a result, the area is a recipient of population overspill from the metropolis and nearby provinces. By virtue of Presidential Proclamation 1594 dated October 1976 under R.A. 7586 otherwise known as the National Integrated Areas System (NIPAS) Act, Mts. Palaypalay/Mataas na Gulod National Park has been decreed as a Protected Landscape.

Presently, there are a few tenured migrants in the park scattered in different areas within the vicinity of Mamba River and in the area of its tributaries which are Cacabay, Kayapas, and Pinagsabangan Rivers. The study aimed to determine the water quality of Mamba River and classify it according to standards set by the DENR-EMB for water classification and to provide baseline data on the physico-chemical properties of the river.

2. Methodology

2.1. Study Site

Mts. Palaypalay/Mataas na Gulod National Park (MPMGNP) is situated between 14°42" to 14°17"N latitude and 120°38" to 120°42"E longitude. It is located within the municipalities of Ternate, Cavite and Nasugbu, Batangas. Its total land area is 4,000 hectares. (COS website of MPMNGNP, 2006). Mamba River is located at this site. It continuously flows throughout the year.Tributaries of the river include the Casabay,

Cayapas, and Pinagsanhan rivers. Mamba River flows from Sitio Magabi, through Sitios Mamba, Murangdalig, then to Sitio Anahaw (Luyon and Medicilo, 2004).

The area falls within the prevailing weather conditions which is dry with two pronounced seasons. It is dry from November to April and wet during the rest of the year (De Los Reyes and Susas 1997). The average rainfall is approximately 2,000 mm per year with highest recorded rainfall during August. The average humidity is 57%. The month of April has the lowest humidity. (DLSU-D website, 2006)

2.2. Water Sampling Method

Water sampling was done to determine the quality of water of Mamba River. Water samples were collected from the river at five sampling points namely right, left, center, upstream, and downstream of the Mamba River. Collection of water samples was conducted once a month for twelve consecutive months. Monthly sample collection was performed at three different sampling times namely early morning, noontime and night to determine if there are differences in the results of the different sampling time.

Prior to physical and chemical analysis, glass containers were cleaned to remove all extraneous surface dirt. They were rinsed with distilled water and drained before use. Approximately 1000 mL of water sample per sampling point and per sampling time was collected. Collected samples were placed in an ice cooler and transported promptly to the laboratory for analysis.

2.3. Physico-chemical Analysis

Water temperature and pH were measured *in situ*, using handheld pH meter (Millwaukee, N-21919) and thermometer (0-360°C,76mm Immersion zeal,N_2 filled, made in England) The other parameters like phosphate and chlorides were tested in the laboratory using Hach (Germany) test kits models PO-23 for phosphate, and CN-66 for chlorides.

The total dissolved solid (TDS) was determined using Gravimetric Method. The water samples were individually filtered and 100 mL of the filtrate evaporated in a pre-weighed evaporating dish. The increase in mass over that of the empty evaporating dish represents the TDS in mg/L. Weighing was done using an analytical balance (ABS 220-4, KERN & Sohn GmbH).

Computation: $$\text{TDS in mg/L} = \frac{(A - B) \times 1000}{\text{sample volume, mL}}$$

Where: A = mass of sample + weight of evaporating dish, mg

B = mass of evaporating dish, mg

The total suspended solid (TSS) was also determined using Gravimetric Method. 100mL of water sample was evaporated to dryness using a pre-weighed 100mL beaker. After evaporation the beakers were placed in desiccators before weighing.

Computation: $$\text{TSS in mg/L} = \frac{(B - A) / 100\text{mL}}{100 \times 1000}$$

Where: B = mass of 100mL beaker with evaporated sample

A = mass of 100mL empty tared beaker

The dissolved oxygen (DO) concentration was determined using a dissolved oxygen meter (YSI, Model 550-12, USA) after careful water sampling. The electrode probe senses small electric currents that are proportional to the dissolved oxygen in the water.

The biochemical oxygen demand (BOD) was determined using the Dilution Technique. Samples were stored in standard 300-mL BOD glass bottles. The test for the 5-day, 20°C BOD of the water sample involves taking an initial measurement when the test begins at t = 0 and a second measurement at t = 5 after the sample has been incubated in the dark for five days at 20°C. The BOD is the difference between the two measurements.

Computation: $$\text{BOD in mg/L} = \frac{D_1 - D_2}{P}$$

Where: D_1 = DO (in mg/L) of diluted sample immediately after preparation.

D_2 = DO (in mg/L) of diluted sample after 5 days incubation at 20°C.

P = decimal volumetric fraction of sample used.

2.4. Analysis of Data

After determining the physical and chemical characteristics of water samples, the gathered data were grouped according to three seasonal variations namely; rainy (June to November), cool dry (December to February), and hot dry season (March to May). The mean values were computed and compared with the standards set by Department of Environment and Natural Resources-Environmental Management Bureau (DENR-EMB) for each particular season. The grand total mean for each parameter for the whole year were also taken and compared to the water standards set by DENR-EMB. Interpretation for each parameter was given thereafter.

3. Results

Physical and chemical characteristics of Mamba River were monitored and analyzed for twelve months. The results were compared with the standard set by DENR-EMB. *Table 1* shows the total mean of physical and chemical characteristics of Mamba River for the whole year as compared to the standards set by DENR-EMB.

Mamba River has an average temperature of 26.2°C during rainy season and decreased by 0.2°C during cool dry season. There is an increase of 2.5°C during hot dry season but still within the standard. The pH of Mamba River has an average value of 8.5 pH units during the rainy season. There is a decrease of 0.7 pH units during cool dry season and increased by 0.1 pH units during hot dry season. The pH value during the whole year is 8.1 and it is within the standard value, (DENR-EMB limit: 6.5-8.5). The river has a total mean of 210 mg/L of total dissolved solids (TDS) during rainy season. An increase of 3 mg/L and 18 mg/L was monitored during cool dry and hot dry season respectively of which values are within the limit, (DENR-EMB limit : 1000mg/L).The total suspended solids (TSS) during rainy season is 198 mg/L and decreased by 48 mg/L during cool dry season. During hot dry season, an increase of 13 mg/L was recorded. The noted increase or decrease in the TSS values still falls within the acceptable limit of not more than 30% increase (DENR-EMB standard). Chloride level has an average value of 0.07 mg/L during rainy season and decrease by 0.06 mg/L during cool dry season. However, absence of chloride was observed during hot dry season, this finding may be attributed to the very low level of water and less human activities in the river. Besides, chloride concentration easily drops with the presence of sunlight and at high temperatures. Phosphorus has a mean value of 0.47 mg/L for the whole duration of the study, which is below the standard. However, during the cool dry season it was noted to conform with the standard (DENR-EMB limit is 0.2 mg/L).The 5-day 20°C Biochemical Oxygen Demand (BOD) during rainy season was monitored at an average of 0.47 mg/L, which did not conforms the standard (DENR-EMB limit : 5 minimum & 10 maximum). However, the total mean for the whole year conforms to the standard. Dissolved Oxygen (DO) for the whole year conforms to the standard. For the whole duration of the study, color is not within the standard set by DENR-EMB.

Table 1. Results of physical and chemical characteristics of Mamba River in Mts. Palaypalay/Mataas na Gulod National Park, Ternate, Cavite for the whole year. Values shown are total mean and standard limits set by DENR-EMB for surface waters

Parameters	Unit	Total Mean/Observation	Standard Set by DENR-EMB	Interpretation
Water temperature	°C rise	26.9	Increase over ambient temperature not more than 3°C	Within the standard
Color		light brown to more intense light brown	No abnormal discoloration from unnatural causes	Below the standard
pH		8.1	6.5 – 8.5	Within the standard
Total Dissolved Solids (TDS)	mg/L	210	1000 mg/L	Within the standard

Total Suspended Solids (TSS)	mg/L	170	Not more than 30% increase	Within the standard
Chloride as Cl	mg/L	0.03	250 mg/L	Within the standard
Phosphate as Phosphorus	mg/L	0.47	0.2	Below the standard
5-Day 20°C BOD	mg/L	6.68	5 (minimum) 10(maximum)	Within the standard
Dissolved Oxygen (DO)	mg/L	6.77	5(minimum)	Within the standard

4. Discussion

Based on the data, the study shows that Mamba River has higher phosphate content as compared to the DENR-EMB standard of 0.2 mg/L. This condition is expected because heavy rains increase the downpour of top soils containing naturally occurring phosphorus from the surrounding uplands (Helmer and Hespanhal, 1997). The high BOD can be attributed to the increase of discharges into the rivers such as contaminated top soils and other domestic wastes from the neighboring dwellers brought about by heavy rains. This situation primarily leads to the breakdown of organic matter in the river, thus, it increases the amount of microorganisms thereby oxygen uptake by microorganisms lowers the concentration of dissolved oxygen (Cabuhal 2004). The increase or decrease of water temperature can also affect the characteristics of the river. When the water gets warm, water and nutrients mixed evenly throughout the water and oxygen is replenished. This oxygen is being used by microorganisms in Mamba River that results to the lowering of the concentration of dissolved oxygen. In general, the increase of temperature of Mamba River for the whole year did not affect its condition because no abnormalities have been observed like degrading of habitats and decrease of photosynthetic activity. The increase of water temperature is directly related to total dissolved or suspended solids (TSS and TDS). An increase of the value of these parameters can increase the surface water temperature because suspended particles absorb heat from sunlight. It can also reduce the color of the water and can affect photosynthesis. (IWR-MSU 1997). Heejun Chang study of Han River also shows no significant increase in temperature for the whole duration of the research while Odemis and Evrendilek study of National Watersheds in Turkey shows increasing trend in river water temperature, at a mean annual rate of about 0.2°C. During the whole year of monitoring, an increase of TSS and TDS were noted. The increase is possibly because of the quarrying activity in Mts. Palaypalay and other activities such as bathing and fishing.

Some organisms in the river are sensitive to changes in pH and some of them may not be able to tolerate the changes. Decline in pH can cause toxicity to many fish and may result to death. For example, a pH of 4 or less cannot be tolerated by a fish in the river. Low pH can also increase the amount of heavy metals. (IWR-MSU 1997) In the case of Mamba River, an average increase of pH of 2 units was monitored, meaning, the water is safe for aquatic organisms.

The quarrying activity in Mts. Palaypalay directly affects the color of water in the Mamba River especially during rainy season since the river is just beside the quarrying site. Some chunks of mountain slopes break off; slide down into the side of the mountain and goes into the river because of quarrying. Throughout the twelve-month monitoring activity, the color is noted to be light brown to more intense light brown. This does not conform to the DENR-EMB standard which states that no abnormal discoloration (changes color of water to light brown or more intense light brown) from unnatural causes must be observed (DENR-EMB, 1990).

The presence of chloride in a very small amount was also detected at Mamba River. This is good because high chlorine content can cause poisoning of aquatic organisms. Chloride is detrimental when come in contact in some of the body parts each time one bathes, or swims in the river (Bordin, 2007). This result is totally different from the findings of Moskovchenko, Babushkin and Artamonova in their study of Vatinsky Egan River catchment in West Siberia which shows wide and high concentration range of chloride.

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

contact recreation such as bathing, swimming, and skin diving. The Mamba River can also be developed for aqua culture purposes, and it is suitable for fish propagation and growth.

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