

PENINJAUAN STATUS LINGKUNGAN EKSISTING SUNGAI MARIKINA, FILIPINA

REVISITING THE CURRENT ENVIRONMENTAL STATUS OF THE MARIKINA RIVER, PHILIPPINES

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Abstract: The physico-chemical characteristics of the Marikina River in an urban area of Metro Manila, Philippines was determined to evaluate the current degree of pollution. The study focused on one source at the site with general coordinates of 14°38'07.95" N, 121°05'36.33" E based on the World Geodetic System (WGS), at an average surface water elevation of around 9 m above mean sea level (AMSL). The area was chosen because of its proximity to a main road and the presence of an outfall from a cemented pipe near a major shopping mall. Comparing the results from the sampling source with the DENR effluent standards for surface waters based on (DAO-2016-08, US-EPA), the effluent is considered as too polluted to be discharged to the surface water in terms of Total Dissolved Solids (TDS: 608.9 mg/L) and Phosphates (PO₄: 12.46 mg/L). The pH (6.9) and Nitrate (0.17 mg/L) of the effluent conforms to standards. A Stream Visual Assessment Protocol was conducted with a resulting Protocol Score of 5.7, which is relatively low for a moving water body. The failure to conform to set standards using the physico-chemical components is supported by the land-use profile which shows that domestic (85%), industrial/commercial (10%) and agricultural wastes (5%) greatly affect the water quality of the river. It is our recommendation therefore that continuing information and education campaigns for the maintenance of water quality be regularly conducted for the residents along the riverbanks to create awareness of the importance of keeping the water clean through minimum direct waste contributions.

Keywords: Physico-Chemical characteristics, Marikina river, water quality

INTRODUCTION

The importance of groundwater is very crucial to every mankind. The use for groundwater and surface water varies in wide ranges: residential, industrial, agricultural and sometimes people tend to depend on it for consumption. Different water bodies pose many risks because sometimes it can be subjected to pollution. Groundwater can be affected by the status of the surface water and different water qualities such as turbidity, temperature, pH, color, total dissolved solids and nitrate content can be correlated to the surface water conditions of a water body (Chin and Qi, 2000 , Dohare et al, 2014)

The Marikina River is a limited practical source for the residents in Marikina (Philippines) besides the different sources provided in Metro Manila (Philippines). The

groundwater in the area is directly related to the Marikina River. The river lies in the middle of two (2) residential and industrial establishments. Pollutants affecting the river are coming from both the industrial and residential areas. The possible observation of the physico-chemical properties this 2019 could be key for future steps in treating the urban river.

This study is limited to a certain part of Marikina River. The site has general coordinates of $14^{\circ}38'07.95''$ N latitude and $121^{\circ}05'36.33''$ E longitude based on the World Geodetic System (WGS), and has an average surface water elevation of around 9 m above mean sea level (AMSL).

As shown in figure 1, the sampling location is a double box culvert effluent along Marikina River which caters to approximately 315 hectares of mixed-use land in Marikina City. This 315-ha catchment area covers various *barangays* including portions of *Brgy. Sto. Nino*, *Brgy. Sta. Elena*, *Brgy. Concepcion Uno*, and *Brgy. San Roque*.



Figure 1. Site Location using Google Maps and Google Earth

Rivers which run through urbanized cities have been studied mostly to observe and identify the effects of urbanization of its quality. Several authors have talked about the deterioration of water quality related to urbanization (Ouyang et al, 2006; Giri, S and Oiu

Z, 2016)..Numerical models have been put forward to assess the impact of such urbanization to the surface waters running along largely populated areas (Saeed, T and Khan, D, 2014)..These papers have discussed the effects of unpleasant practices which contribute to such deterioration of water quality, in China, the Pearl River and the Yangtze River have been greatly affected not only by the land use along these sites, and it was noted that along with urbanization, agricultural uses have also been contributing to the deterioration of water quality.

In the Philippines, the largest river in Metro Manila, the Pasig River, has been studied and the contributions of its tributaries to the water quality of the river has affected not only the Pasig River but also the Manila Bay, the receiving body of water of the Pasig river. Being one of the major tributaries of the Pasig river, the Marikina River has a big impact on the water quality since it is one of the largest tributaries to the Pasig River (Santillan and Paraiso, 2010)

RESEARCH METHOD

Rapid urbanization and development causes the surface water to have a lower quality, therefore additional sources of potable and clean water are needed. Thus, the study of the Physico-Chemical properties of the surface water is an important step towards making the next necessary steps in treating or improving the environmental status of a body of water.

1. Parameters to be analyzed

Assessment of the water quality in the *Marikina River* considered the following tests/ parameters (a)pH, (b) Temperature, (c) Total Dissolved Solids, (d) Nitrate, (e) Phosphate, (f) Electric Conductivity, (f) Ammonia (h) Stream visual assessment protocol.

2. pH

The pH of most natural waters lies in the range of 6 to 9. It is a condition necessary to support most life, although some microorganisms can grow at pH values less than 4 and greater than 9. It is important to note that drinking water pH also lies from 4.4 to 8.5

(Dohare et al, 2014 , Saeed and Khan, 2014)

3. Temperature

Most of the water temperatures are consistent in range and do not have temperature fluctuations of more than a few degrees. Most individuals find that water having a temperature between 10-15°C is most palatable. In tropical countries, wastewater temperatures usually range from 15 to 26°C. Water in the different water bodies appear warmer because water from the household pass through different heating systems. According to Philippine standards (DAO 2016-08) the temperature range of bodies of water in the Philippines normally ranges from 26-32°C (Department of Environment and Natural Resources, 2016).

4. Total Dissolved Solids

Total Dissolved Solids (TDS) measure the organic and inorganic content present in the liquid in different forms. The acceptable limits per US EPA standards is 500ppm (Maximum value) (United States Department of Agriculture Natural Resources Conservation Service, 1998)

5. Nitrate

Nitrate is generally present in the form of an N₂ compound. Nitrate can come from different sources, it can come from animals, decaying plants, industrial, domestic and agricultural wastewaters and a high concentration of nitrate usually points out to a heavy pollution problem in the water body. Per DAO-2016-08 standards the maximum value for Nitrate would be 15ppm (Dohare et al, 2014 , United States Department of Agriculture Natural Resources Conservation Service, 1998)

6. Phosphate

Due to the low solubility of phosphate in water bodies there is a high possibility that the concentration is very low. Per DAO-2016-08 standards the maximum concentration of phosphate is situated at 5ppm (Dohare et al, 2014 , United States

Department of Agriculture Natural Resources Conservation Service, 1998)

7. **Electric Conductivity**

Electrical conductivity is usually associated to the presence and amount solids in the target body of water. These ions help the water conduct electrical current. Most common constituents of the water body that is related to electrical conductivity are phosphates, nitrates and some mineral and metals (calcium, sodium, potassium, chloride). Per USA EPA standards the conductivity should be limited to 150 to 500 μ S (Dohare et al, 2014 , United States Department of Agriculture Natural Resources Conservation Service, 1998 , Saeed and Khan, 2014)

8. **Stream Visual Assessment Protocol**

The stream visual assessment protocol or SVAP (USDA- NRCS version) was used to initially evaluate the conditions of the short stretch of the urban river where the target effluent is situated. The qualitative assessment included approximate spatial measurements, descriptions and presence of living organisms and basic level analysis of the physical attributes of the river (United States Department of Agriculture Natural Resources Conservation Service, 1998).

RESULTS AND DISCUSSION

Stream Visual Assessment Protocol

Table 1. Stream Visual Assessment

<i>Date of SVAP</i>	April 28, 2019
<i>Stream Name</i>	Marikina River
<i>Reach Location</i>	upstream of Manggahan Floodway Gate

<i>Drainage Area</i>	~315 ha
<i>Gradient</i>	~1.2% (based on Google Earth projection)
<i>Applicable Reference Site</i>	~650 m away from Marikina City Hall
<i>Land Use within Drainage (%)</i>	85% residential, 10% industrial/commercial, 5% green and open areas
<i>Weather Condition</i>	Clear / Sunny
<i>Active Channel Width</i>	60 m
<i>Dominant Substrate</i>	Silt and Mud

Channel Condition

Residential and Industrial use of land changed creeks of the Marikina River. Due to this the evaluated score for the water body would be **10** (United States Department of Agriculture Natural Resources Conservation Service, 1998).

List of significant floods noted in the area:

- Typhoon Ketsana/Ondoy – September 2009
- Typhoon Meari/Falcon – June 2011
- Typhoon Nesat/Pedring – September 2011
- Typhoon Haikui – August 2012
- Tropical Storm Karding – August 2018

Riparian Zone

Insects and different organisms provide organic material for stream biota that serves as food chain for aquatic lives. Due to this the evaluated score for the water body would be **10** (United States Department of Agriculture Natural Resources Conservation Service, 1998). Vegetation are present in both sides of Marikina river. These reduce the amount of pollutants that fall within the river vicinity after runoff. This vegetation also controls erosion in the area. Although this vegetation does not contribute in dissipating energy during flood events, these provides habitat for terrestrial.

Bank Stability

Excessive erosion of banks occurs where streams are unstable due to changes in different properties (hydrology, sediment load, etc.). Streams that are more susceptible to erosion are those that are higher and steep. A major factor that affects bank stability is its riparian zone and soil type, specifically surface soil. The Marikina river banks have been vegetated causing it to be more stable. Construction of ripraps also provid the *Marikina River*

Bank which caused the water behavior to change drastically. The river bank had 28,000 has. Of forest lands during in its early stages (1904) and slowly transformed into grasslands, paddies, dry fields, some turned to villages and subdivisions and poultry farms. Between 25 to 50% of the topsoil of the Marikina water shed has already eroded, this caused for a decreased loading capacity with a high overbanking rate during times of heavy rainfall, which causes flooding. Due to this the evaluation is to have it a rating of **7** (United States Department of Agriculture Natural Resources Conservation Service, 1998).

Hydrologic Alteration

Due to its low-altitude location, Marikina City is regularly exposed to high levels of water. Heavy flooding happens from August to November in the Philippines. Rapid urbanization also resulted to an increase in impervious ground surface resulting to an

increase in rate of the volume of run-off. River easement and a different drainage system eliminates the different passageways for runoffs. Dumping of wastes directly in the river also factors in, together with the domestic, and industrial waste discharged and canals that drains into tributary stability for the river. Due to this the evaluated score for the water body is 7 (United States Department of Agriculture Natural Resources Conservation Service, 1998).

Water Appearance

Water in the river appears to be cloudy and opaque-like. This is probably due to a high concentration of particulate matter, the color affects light penetration and ecological productivity, habitat quality and it causes the river to fill in faster. These particles provide attachment places for other pollutants namely heavy metals and some bacteria. Due to this the evaluated score for the water body is 3 (United States Department of Agriculture Natural Resources Conservation Service, 1998).

Nutrient Enrichment

Presence of water hyacinths was observed in some parts of the water body and it may indicate that there is a mild pollution in the water body. Eutrophication can be a factor for this due to excessive nutrient loading on the surface water (Yang et al, 2008). Due to this, the evaluated score for the water body would be 3 (Oyem et al, 2014)

Barriers to fish movement

There are no necessary constraints to fish movement. Structures around the river are less than 1ft. Due to this the evaluated score for this property is 5 (United States Department of Agriculture Natural Resources Conservation Service, 1998).

Instream fish cover

Different covers in the area are only found to be the water lilies which are constantly being removed from the water. Other possible covers cannot be evaluated due to the water's turbidity. Due to this the evaluated score would be 1 (United States Department

of Agriculture Natural Resources Conservation Service, 1998).

Pools

The river has a smooth and undisturbed surface. The slow current and its depth make the water a bit stable. Depth of the river ranges from 3 to 21 meters (9.8 to 68.9 ft) and spans from 70 to 120 meters (230 to 390 ft). River elevation of approximately 8 meters above sea level at the boundary of 2 subsequent cities (*San Mateo, Marikina*) the elevation depresses down to 4 meters (13 ft) nearly before the next city boundaries (*Malanday, Santo Niño*). The elevation, which is the lowest between the boundaries is about 2 meters (6 ft 7 inches) above sea level. Due to this the evaluated score for the water body is **10** (United States Department of Agriculture Natural Resources Conservation Service, 1998).

Insect/Invertebrate habitat

Marikinar river play host to water lilies and janitor fish in distinct parts of the area. The appearance of the water is murky and life forms/creatures can be rarely be seen in the river. It was classified as biologically dead by the Philippine Government in year 2003 (Pasig River Rehabilitation Commission, 2014). This is primarily due to the high organic loading in the area.

Table 2. Summary of Scores for SVAP

Land/Water Forms	Score
Channel Condition	7
Hydrologic Alteration	10
Riparian Zone	10
Bank Stability	7
Water Appearance	3
Nutrient Enrichment	3
Barriers To Fish Movement	5
Instream Fish Cover	1

Pools	10
Insect/Invertebrate Habitat	1
Canopy Cover - Cold Water Fishery	N/A
Canopy Cover - Warm Water Fishery	N/A
Manure Presence	N/A
Salinity	N/A
Riffle Embeddedness	N/A
Macroinvertebrates observed	N/A
Overall Score	57/10 = 5.7

Table 3. Physico-Chemical Properties

Parameters	Average Values (3 Trials)
TDS (ppm)	608.9
TEMP (°C)	28.8
CONDUCTIVITY	656.07
pH	6.97
PHOSPHATE	12.46
NITRATE	0.170

Table 4. DAO 2016-08 and US EPA Standards Comparison

PARAMETERS	AVERAGE VALUES	DAO 2016-08 STANDARDS	US EPA STANDARDS	REMARKS
TDS (ppm)	608.9	--	500 (max)	Above max limit may cause coloration
TEMP (°C)	28.8	25 - 32	--	Within acceptable value
CONDUCTIVITY	656.07	--	50 to 500	May not be suitable for certain species of fish
pH	6.97	6.0 - 9.0	--	Within acceptable value
PHOSPHATE	12.46	5 (max)	--	Above maximum limit

NITRATE	0.170	15 (max)	--	Way below the maximum value
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CONCLUSION

The study aimed to determine the current physico-chemical properties of an effluent in Marikina River and how these parameters affect the ability of the river to sustain life and its physical vulnerability against river contaminants. From the gathered data, Marikina River can be classified as a Class D freshwater body, the river is relatively neutral with pH of 6.97 at 28.8 Celsius, values within the acceptable limits of DENR's DAO 2016-08. Nitrate is also below the maximum value of 15mg/L as set by the national standard. The total dissolved solids or TDS is above the maximum limit set by the US EPA. According to the US EPA's water monitoring guidelines, a TDS value of more than 500ppm may cause coloration to the water body. This is in fact true to the Marikina river which reflects greenish brown color within the area observed during the conduct of the site investigation. Other parameters such as conductivity and phosphate directly affect the aquatic biota in a stream if not maintained or monitored. Conductivity as based on the US EPA guideline may not be suitable for some specific species of fish. On the other hand, excessive amount of phosphate causes a fast propagation of algae/microalgae and water lilies which is evident in some portions of the river, this can be attributed to eutrophication. Overall the water body can still recover through different types of treatment but for now, it will be classified as a river that is *biologically dead*.

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