RIPARIAN HABITAT AND WATER QUALITY OF AYALA RIVER, ZAMBOANGA CITY, PHILIPPINES

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ABSTRACT*: This paper is part of an original work conducted to assess the condition and status of Ayala River in Zamboanga City, Philippines in terms of its riparian habitat and water quality. Belt transects were laid out along 100 established baselines within the identified three sampling sites designated as a lower stream, middle stream, and upper stream. Habitat and water quality were assessed through biotic and abiotic components using a rapid field data sheet and HORIBA, respectively, as well as laboratory analysis for nitrate and phosphate contents. The result revealed that Ayala River is no longer covered with original vegetation, but with exotic and invasive plants which have contributed to chemical alteration of the river water quality. The presence of crops and pioneer species would indicate that the riparian zone of Ayala River is massively encroached with agricultural land use and has been subjected to cultivation. The three sampling sites were within the agricultural and residential land uses. The agricultural land use stretches from upper to lower streams. Residential land use has engulfed the greater portion of the lower stream. The habitat status of Ayala River belongs to the marginal type of habitat that is generally disturbed and less suitable for species habitation because greater portions of the riparian areas along the Ayala River are disturbed. The river water quality is classified as Classes A and B which are good sources for water supply and recreational purposes. It is concluded that if no rehabilitative measures will be undertaken for its sustainable conservation and management, the Ayala River will no longer be suitable for species habitation and safe for drinking as the greater portions of the river are categorized as marginal and poor which are described as disturbed.*

KEYWORDS: assessment**,** riparian, water quality, habitat, ayala river

1.0 INTRODUCTION

Riverine is one of the most diverse ecosystems on earth and provides important services. Understanding how they function is critical to sustainable management, but a challenging one given its complex spatial and temporal structures, and multi-scale processes. The river is multidimensional, including longitudinal (upper stream-lower stream), lateral (upland to channel), vertical (hypothec, or the zone below the stream bed), and temporal components. Moreover, it is also organized hierarchically, with fine-scale structures (e.g., gravel patches) embedded within channel bed features (e.g., riffles), which in turn, are embedded within reaches, valley segments basins, and regions. The river also can be characterized according to its width (narrow and wide), depth (swallow and deep), current (slow and fast), meanders (bends and turns), eddies (spots of the river usually at the edges), banks (gently sloping, steep, drop, cliff), and bottom (small rocks, big rocks, muddy). The river carries water and nutrients and plays a very important part in the water cycle. It is acting as a drainage channel for surface water which provides excellent habitat and food for many of the earth's living organisms [1].

The river is a body of water that comprises hydrological-ecological networks formed by a flow of water, sediment, nutrients, and the movement of aquatic organisms in the upper and lower streams. Moreover, it is mainly composed of four dimensions, namely: longitudinal (upper stream to lower stream), lateral (upland to channel), vertical (zone below the stream bed), and temporal components. It plays an important role in the water cycle acting as a drainage channel of surface water, providing favorable habitat and food for many organisms, and effectively irrigating farmlands planted for different crops. However, the agricultural sector has suffered a heavy loss in agricultural production due to devastations caused by floods often brought about by perennial typhoons which can no longer be contained by the river systems [2]. The increase in population, climatic changes that resulted in flash floods, and prolonged drought coupled with the expansion of irrigation have contributed much to a drastic increase in the use of and need for water resources.

River quality is generally linked to land use/land cover in the catchment, and many studies have been focusing on their relationship with water quality variables such as dissolved salts, suspended solids, and nutrients. It has been reported that agricultural land and urban uses strongly influenced nitrogen and phosphorus, and are also responsible for more localized erosion types, such as bank erosion at rivers and lakes, delivering substantial loads of fine sediments to aquatic ecosystems [3]. Land use and land cover are also explicitly linked with carbon, water, and nutrient cycles within the ecosystems which have been continuously changing due to natural and anthropogenic processes [4]. Land use has effects on stream conditions in the watershed which is dominated by intensive row crop agriculture and low-intensity urban development quantifying relationships among land cover, stream invertebrate assemblages, and other stream biophysical characteristics [5]. Surface water quality has degraded primarily due to deforestation and conversion to agricultural lands and the loss of wetlands [6]. Moreover, it has been confirmed that intensive urban and cultivated land uses at the catchment scale degraded stream biological communities [7].

Zamboanga City is endowed with several rivers. One of its major rivers is Ayala River which is located on the west coast of the city. Its estimated terrain elevation is four meters above sea level. The estimated mean annual run-off of the river is 11,640,000 cubic meters and has a catchment area of 2,784 hectares. It is located within geographic coordinates with a Latitude of 6.9600° and a Longitude of 121.9447° [8]. It is one of the water quality management areas in Zamboanga City. It steers southward and curves southwesterly at Barangay Baluno and traverses through Barangays La Paz, Tulungatung and finally, drains and empties its waters into the coastal area of Barangay Ayala facing the Sulu Sea. The Ayala River was designated as one of the Water Quality Management Areas (WQMAs) under

DENR Administrative Order No. 15 dated June 21, 2016 [9].

The characterization of physical habitat elements is fundamental in ecological studies (i.e., riverine ecosystem) that are designed to explain physical heterogeneity, distributional patterns of organisms, composition, and structure of biological communities or ecosystem function [10]. The river's physical habitat is characterized by categorizations such as Optimal which is described to be functioning and most suitable for habitation, Sub-optimal as functioning well but less suitable for habitation, Marginal as less disturbed but less suitable for habitation, and Poor as being disturbed and not suitable for habitation. Study on the selected critical rivers in Mindanao [11].

An evaluation of the riparian vegetative habitat condition is critical to any assessment of ecological land, and the water quality is an important component of river habitat assessment such that when the water is poor, it affects not only aquatic life, but also the surrounding ecosystems as well.

2.0 METHODOLOGY

2.1 Study Locale

The study was conducted at the established riparian sites along the Ayala River (Figure 1). The study locale was selected because of its typicality of being less studied and may perhaps be the first study such as this to be conducted in the said river.

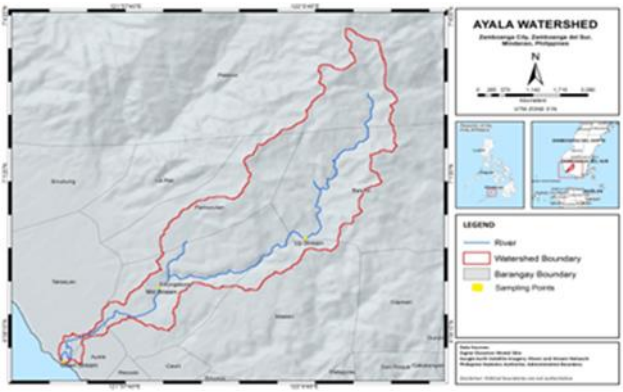

Figure 1. Location of Sampling Sites in Ayala River.

2.2 Sampling Site Establishment

In this study, there were three (3) established sampling sites for assessment identified as a lower stream, mid-stream, and upper stream areas along the riparian of Ayala River. Site 1 (lower stream) is located at Barangay Ayala, Site 2 (mid-stream) is located at Barangay La Paz and Site 3 (upper stream) is located at Barangay Baluno. The geographic locations of the sampling sites were recorded using a Geographic Positioning System (GPS) device. In each sampling site, 100-meter transect lines were established along the riverbanks and laid out five meters away from both sides of the river for riparian habitat assessment.

2.3 Data Collection Methods

The land uses associated with each sampling area were assessed through visual observation traversing the Ayala River. This data provided the actual situation of the sampling areas which were used for further analysis on the impacts of biotic and abiotic characteristics of the Ayala River.

Water quality condition of the river was determined in terms of physicochemical parameters using a multi-parameter probe (HORIBA) for direct field measurement of turbidity, total suspended solids, total dissolved solids (TDS), pH, temperature, and dissolved oxygen (DO) of the river measured. The measurement of the water quality was done by dipping the multi-parameter probe into the water (mid-section of the river) and data reading was recorded in each sampling site. The water samples were collected for laboratory analysis of the nitrate and phosphate contents of the water. The result was later compared with the standard prescribed under DAO 2016-08, otherwise known as the Philippine Water Quality Guidelines and General Effluent Standards of 2016. A visual-based vegetative habitat evaluation was done using the Rapid River Assessment Field Data Sheets for biotic and abiotic resources.

2.4 Data Analysis

The means (overall score) in each study site and the given parameters were calculated from the data gathered. For water quality, a comparison of values between the measured ones and the values given as prescribed under DAO 2016-08 was done for analysis, and land uses were described.

3.0 RESULTS AND DISCUSSION

3.1 Water Quality of Ayala River

The water quality of Ayala River has generally passed the water quality standard as prescribed under DAO No. 08 series of 2016 except turbidity which obtained failing values in all sampling sites averaging to a total score described as "Failure" in its rating to meet the set standard for Philippine water quality mandated under the same administrative order (Table 1).

Table 1. Ayala River Water Quality Against the Standard

Parameters	ARWQ	WQS (DAO 2016-08)		
	Mean	Class A*	Class B*	Remarks
Temperature	28.55	26-30	26-30	Passed
pH	7.98	6.5-8.5	6.5-8.5	Passed
Turbidity	99.66	5	5	Failed
DO	7.7	5	5	Passed
TDS	148.33	1000*	500	Passed
TSS	46	50	65	Passed
Nitrate	<0.01	7	7	Passed
Phosphate	0.113	0.5	0.5	Passed

Legends:
ARWQ = Ayala River Water Quality
WQS= Water Quality Standard
Class A*= Public Water Supply; Class B*=Recreational Water
TDS (1000*) = not applicable if the natural background is higher in concentration as the latter prevails over the former and can be used as a baseline.

The water quality of Ayala River has met the prescribed water quality standards for Class A and Class B. To this effect, Ayala River is a good source of public water supply and is safe for recreational activities bathing, swimming, etc. All sampled sites indicated that the water quality of Ayala River is still in conformity with the set standard when used for public water supply and recreational purposes.

The water clarity and haziness of Ayala River as indicated by the values of turbidity would perhaps be attributed to the occurrence of rainfall for three successive days prior to the conduct of the assessment. The assessment was conducted for three successive days on January 29, 30 & 31, 2018

from 8:00 am-10:00 am. Each sampling site constituted one half-day assessment. The value of turbidity might have been impacted by the erosion in the form of run-off from the uplands and the immediately eroded riverbanks due to poor riparian vegetation and intensive clearings of cultivated lands near the riverbanks.

3.2 Land Uses Associating Ayala River Riparian Zone

Residential houses and other built-ups are evident in sampling sites. It could be gleaned from the land cover stretching through the entire river channel that Ayala River is disturbed and degraded, and its riparian zone and riverbanks have heavily eroded. The nearby areas of the floodplain are agricultural land and have been subjected to heavy land cultivation. The land covers of the middle and lower streams have been massively altered from their original forest consisting of indigenous riparian vegetation (Figure 2). This condition has negative impacts on the river because this would not only contribute to the soil erosion in the floodplain connected to the riparian zone but also changes in the chemical composition of the soil. In effect, these chemicals would be brought down the river channel and subsequently, change the degree and level of water quality due to this chemical alteration.

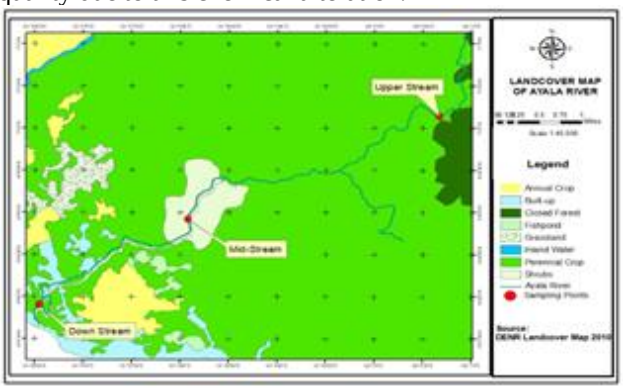

Figure 2. Land cover map of Ayala River

Based on land use classification (Figure 3), the uppermost portion of Ayala River where its headwater is connected is the proposed Ayala Watershed. Moreover, the upper portion where Site 1 is located is classified as a protection forest, and with eastern side is Pasonanca Natural Park. The middle portion of the river where Site 2 is situated is classified as a production forest. The lower portion of the river where Site 1 is located is classified as residential purposes. On the farther northern side of the production, the forest is classified as an agricultural area. It could be gleaned from the land use classification that the lower stream is fully disturbed as it is situated within the residential area. Moreover, the middle portion of the river is situated within areas planted with perennial crops which are a mixture of plantation and perennial crops. Hence, it is expected that the lower stream has poor conditions, and the middle stream is marginal.

3.3 Status of Riparian Habitat of Ayala River

The status of riparian habitat is based on the conditions of the riverine ecosystem consisting of biotic and abiotic components of the river. It would not only deal with the mere identification and description of various species and features of the riverine ecosystem, but also an indication and prediction of the status of the riparian habitat given the parameters used to be measured or described for its condition

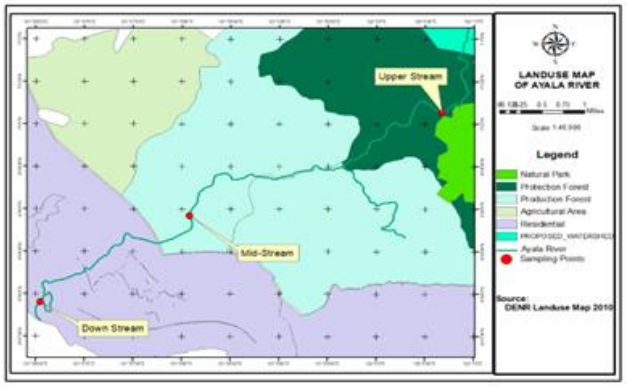

Figure 3. Land use map of Ayala River

Table 2 shows the biotic condition of the Ayala River based on the sampled areas. In the mean score description, there is only one parameter on “bank vegetative protection” which is categorized as “Sub-Optimal” based on the numerical rating assigned to each descriptive category given to each parameter. Under this category, 70-89% of the stream bank surfaces are covered with vegetation. The rest of the parameters have obtained a rating of mean score described as "Marginal," meaning the status of the riparian habitat of the Ayala River based on biotic conditions is less disturbed and less suitable for habitat.

Table 2. Biotic Component Assessment of Ayala River

Habitat Parameters	Biotic Component							
	Site 1		Site 2		Site 3		Mean	
	R	D	R	D	R	D	R	D
Canopy Cover (Shading	5	P	8	M	13	SO	8.60	M
Bank Vegetative Protection	3.2	P	8	M	8	SO	6.40	SO
Streamside Cover	4	P	8	M	14	SO	8.60	M
Riparian Vegetative Zone Width	4	P	5	M	8	SO	5.60	M
Native Riparian Regeneration Rating	8	M	8	M	9	M	8.33	M
Invasive Exotic Plant Species Cover	9	M	8	M	9	M	8.66	M
Biotic Condition Stressor	5	P	9	M	9	M	7.66	M
Vegetative Horizontal Patch Structure	6	M	8	M	13	SO	9.00	M
Vegetation Vertical Patch Structure	7	M	9	M	12	SO	9.33	M
Total	51.20	P	71.00	M	95.00	SO	72.40	M

Legends: R = Rating; D = Description
P = Poor; M = Marginal; SO = Sub-Optimal

Table 3 shows the abiotic condition of the Ayala River based on the sampled areas. In the mean score description, almost all of the parameters have obtained a rating mean score described as "Marginal," meaning the status of the riparian habitat of the Ayala River based on abiotic condition is on the verge of becoming poor which is no longer good for specific purposes, except one parameter on "bank stability" which was rated "Poor" which is described as unstable, meaning many portions of the riparian areas along the Ayala River are heavily eroded.

Table 3. Biotic Component Assessment of Ayala River

Habitat Parameters	Abiotic Component							
	Site 1-Lower Stream		Site 2-Mid Stream		Site 3-Upper Stream		Mean	
	R	D	R	D	R	D	R	D
Hydrologic Connectivity	2	P	7	M	12	SO	7.00	M
Landscape Condition Stressor	3	P	8	M	11	SO	7.33	M
Hydrologic Condition Stressor	3	9	9	M	13	SO	8.33	M
Physical Structure Condition Stressor	7	M	8	M	12	SO	9.00	M
Physico-Chemical Parameters	2	P	9	M	14	SO	8.33	M
Bottom Substrate/In-Stream Cover	3	P	12	SO	14	SO	9.66	M
Embeddedness	3	P	10	M	13	SO	8.66	M
Channel Alteration	8	M	6	M	14	M	10.00	M
Bank Stability	2	P	6	M	7	M	5.00	P
Total	33.00	P	77.00	M	113.00	SO	73.31	M

Legends: R = Rating; D = Description
P = Poor; M = Marginal; SO = Sub-Optimal

The overall status of the riparian habitat of Ayala River based on the specific riparian habitat status of the three sampled sites is generally rated as "Marginal," meaning less disturbed but less suitable for the habitat of organisms based on biotic and abiotic components assessment (Table 4). This would imply that if left unattended and no rehabilitative measures will be undertaken for its sustainable conservation and management, Ayala River will soon be of no use due to its poor status as being heavily disturbed and fully degraded. Drying up of some portions of the river is possible as evident in the shallowness of the river channel in many portions of the river and the occurrence of embeddedness is very high because of the presence of stones. Soil particle deposition is also high causing deltas in the middle of the channel causing channel alterations and hydrologic stressors. Riverbank erosion is also very imminent and no vegetative controlling measures are undertaken to protect the greater portion of the riverbank. Some portions of the riverbank are protected with structural measures such as riprap.

Table 4. Overall Rating of Habitat Status of Ayala River

Sampling Sites	Rating		Mean	Category
	Biot	Abiotic		
Site 1-Lower Stream	51.20	33.00	42.10	Poor
Site 2- Mid-Stream	71.00	77.00	74.00	Marginal
Site 3- Upper Stream	95.00	113.00	104.00	Sub-Optimal
Overall Mean	72.40	74.33	73.37	Marginal

The general results of the study showed that Ayala River belongs to a marginal type of habitat that is less disturbed and less suitable for habitation based on biotic and abiotic parameters in all sampling sites traversing Ayala River. Upstream is considered a sub-optimal type of habitat with a slope extending from level to gently and severely steep. These affect directly or indirectly the channel characteristics and simultaneously influenced on erosional and depositional processes of the river. The upstream is still functioning well but less suitable for habitation because some areas have still vegetation present along the banks and the forested area present in the upper portion of the area. It has been stated that the richness of surrounding forest cover becomes important for natural restoration in abandoned degraded land [12].

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