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# The DisappearingFish Community in Butuanon River, Cebu, Philippines: The Ignored Impact of Pollution

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***Abstract:Aims and Objectives****: This study generally assessed the impact of the Butuanon river water quality in terms of the abundance and richness of freshwater fish community. Specifically, this study compares 2009 and 2019 fish abundance and richnessofButuanon river in Cebu, Philippines.*

***Methodology:****Test fishing from random stations along the entire length of the Butuanon river were conducted on April 2009-July 2009 and on June 2018-February 2019. All sample specimens were stored in 10% formalin and brought to the laboratory for further processing. Likewise, in-situ and ex-situ measurements of water quality parameters were taken, particularly water temperature,pH, dissolved oxygen (DO), and total suspended solids (TSS).*

***Results:****All of the fish species documented in Butuanon river are hardy species which can tolerate wide ranges of aquatic environmental conditions. In 2009, seven (7) species of freshwater fish were documented while there were only four (4) in 2019. Comparing the 2009 and 2019 data,a 42.9% reduction of species richness of fish in Butuanon river is alarming. Similarly, there was a significant (p-value< 0.05) decline in DO readings between 2009 (32.67 mg/L ± 1.95) and 2019(4.5 mg/L ± 0.27) while there was a dramatic increase in the TSS readings between 2009 (0.67 mg/L ± 0.02) and 2019 (123.3 mg/L ± 9.12). Likewise, temperature and pH measurements significantly (p-value < 0.05)vary between 2009 and 2019 readings.*

***Conclusion:****The significant reduction in the richness and/or the disappearance of some freshwater fish in Butuanon river was seen as a reprehensible effect of uncontrolled deterioration of the river ecosystem condition as exhibited by the lowering DO and increasing TSS. Immediate interventions to save the Butuanon river should be taken with utmost serious considerations.*

***Keywords:****River pollution, Butuanon river, Fish assemblage, Ecological degradation, Environmental protection*

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## I. Introduction

Culturally, rivers have been accommodating society by providing a medium for transport, recreation, tourism, worship, ecosystem services, and a place to experience the serenity of nature [1].The river is also an important habitat to a variety of flora and fauna [2]. Among other aquatic life, fishes are considered as excellent indicators of river ecosystem health as they represent a variety of trophic levels [3, 4]. However, this ecosystem is constantly threatened with pollution, among others, which was brought by uncontrolled and unplanned urban growth [5].Water pollution is a menace that needs to be faced upfront. It does not only destroys an entire aquatic ecosystem and all the life that is living on and dependent on this ecosystem including humans but also add to debilitating problem of water scarcity and crisis [6, 7].

Butuanon river is one of the rivers in the Philippines which is facing the pollution problem[8, 9, 10, 11, 12]. It is a 23-km river traversing highly industrializedcities of Cebu and Mandaue. From the Department of Environment and Natural Resources (DENR) – Environmental Management Bureau (EMB) Region 7 report [13], the river has been used as dumping area of wastes industrial, commercial, and residential establishments. In the DENR-EMB Region 7 list of classified water bodies,Butuanon river was classified in 2000 as a Class Driver, which indicates that it is not safe for human consumption and for recreation. Muego[10] have also reported that Butuanon river is a biologically dead river based on the water quality standards.

From the stories told bythe residents, the Butuanon river was used to be a recreation place in the past where they go swimming especially during summer [14]. The river was also their source of drinking water and water for other household activities such as cooking, bathing, and laundering [15, 16]. They also catch fish from the river

for their protein source and consumption [11]. At present, they are unable to enjoy all those things because of the polluted condition of the river[14].

Several studies had been conducted to determine the extent of river pollution such as those studies that looked at heavy metals in the water [8, 9, 11], sediments [11, 15], and fish [11, 15]. The results of these studies were overwhelming. With this regard, an interagency Butuanon River Watershed Management Committee was formed in 1995 to oversee the rehabilitation of the river. For almost 25 years of existence, the committee have tried a number of initiatives, such as sponsoring annual river clean-up activities [17], but deterioration of Butuanon river still continue[15, 16, 18].

To further illustrate the worsening condition of the river and to find opportunity in prioritizing rehabilitation efforts, this study was conducted showing the fate of the fish communities thriving in Butuanon river. The fish community is among the ignored component of the Butuanon river ecosystem. With all the existing studies conducted on Butuanon river, no studies ever lookedintothe fate and conditions of itsfish communities. Hence, this study was conductedto further assess the impact of the unregulated deterioration of the river ecosystem to its fish composition. Similarly, this study also determined the change in species richness or composition in relation to selected water quality parameter change over a 10-year time interval.

## II. Materialsand Methods

### Description of the Study Site

The headwaters of the Butuanon River originate from the upland areas of Cebu City that are characterized by extensive farming of large-scale mango production and floral cultivation, patches of grassland and thin secondary forest [12], the midstream and downstream portions are characterized by intensive urban sprawl such as residential, commercial, and industrial establishments[11, 15]. The slow-moving of waste in the river channel stretches as far as 10 km with some portions of the river drying up during the dry season[11, 16]. The upstream portion of river is the least polluted while the downstream portion is the most polluted [11].

Along the river, 12 sampling stations were established (Figure 1). These stations were surveyed for freshwater fish assemblage and sampled for water quality parameters on April 2009 – July 2009 and 10 years after on June 2018 – February 2019.

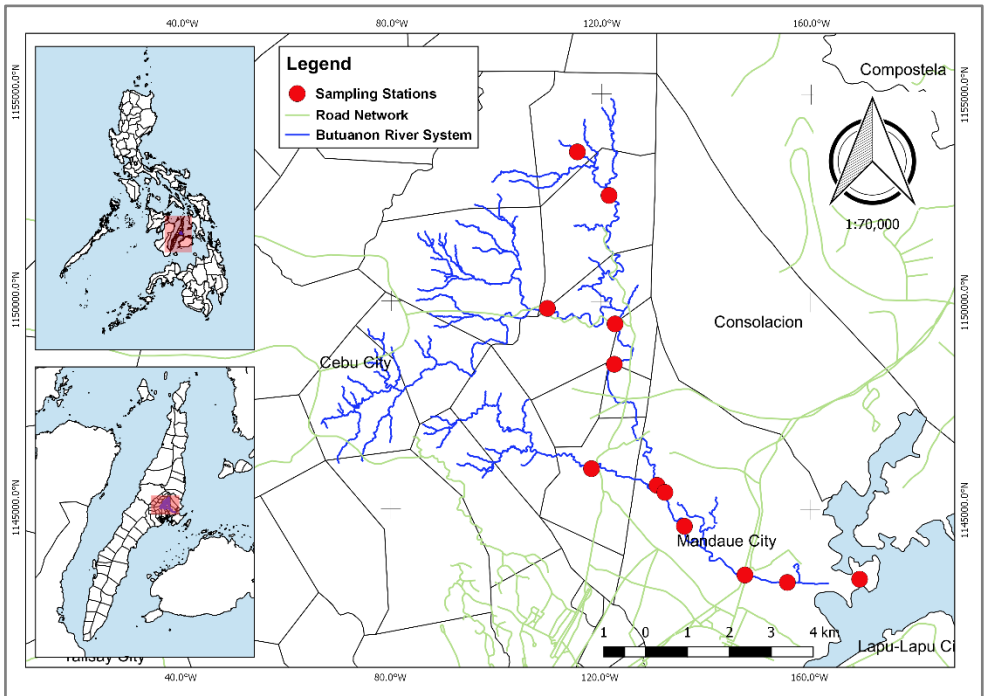


**Figure 1**. Location Map of Butuanon River and the Sampling Stations

### Test Fishing and Water Quality Analysis

In each station, test fishing was performed using gill nets for at least two hours. Individual fishes that were caught were stored in labeled containers with 10% formalin and brought to the University of San Carlos (USC) Department of Biology laboratory for processing.The identification of the fish samples was confirmed and validated by freshwater fish expert from the Mindanao State University – Naawan Campus. Similarly, water quality parameters, such as temperature, pH, dissolved oxygen (DO), and total suspended solids (TSS), were

also taken from each station while conducting the test fishing. The former three parameters were taken in-situ while the latter was sent to USC Water Laboratory for filtration and gravimetric analyses.

**Data Analysis**

The frequency of fish occurrence in the study site was noted following the fish assembly integrity index (FAII) developed by Kleynhans[4], in which the frequency of occurrence at < 34% is considered as infrequentoccurrence. On the other hand, if the frequency of occurrence is at 34 – 67%, it is frequent occurrence while the frequency of occurrence at > 67% is widespread occurrence. Number of species collected between the two time periods, i.e., 2009 and 2019, were compared and the percentage difference was computed.

Conversely, water quality measurement data was analyzed using R studio [19]. The t-test and nonparametric equivalents were used to determine the significance difference between the mean values of different parameters of 2009 and 2019 measurements.

## III. Results

**Fish Assemblage and Richness**

Assessing fish assemblages especially in bodies of water which are threatened with pollution and other disturbances is found to be helpful in determining the health conditions of the aquatic ecosystem. Representing a variety of trophic levels, the fish community serves as a good indicator for long term effects and broad habitat conditions [3, 4]. Likewise, several studies have reported that fish assemblage is influenced by several environmental factors which could be an indicator for pollution and presence of anthropogenic influences [20, 21, 22, 23].Johnston and Maciena[22] added that comparison of contemporary and historical fish collections can provide a valuable means of detecting changes in fish assemblages which is especially useful in detecting cumulative effects of habitat degradation over time.

Out of 310 freshwater fish species reported in the Philippines [24], seven species were recorded in Butuanon river during 2009 sampling. However,there were only four species found to inhabit the river as noted during the 2019 sampling (Table 1),a 42% reduction in the species richness of the river as compared to the 2009 data.

**Table 1:**List of fish species recorded in Butuanon river in 2009 and 2019

| Species | Local (Common) name | 2009 | 2019 | Frequency of occurrence (FAII) | Occurrence |
|---|---|---|---|---|---|
| *Anabas testudineus*Bloch, 1792 | Puyo (Climbing perch) | X | | Infrequent | Introduced |
| *Channastriata* Bloch, 1793 | Haluan (Snakehead) | X | X | Infrequent | Introduced |
| *Clariasmacrocephalus*Günther, 1864 | Pantat (Broadhead catfish) | X | X | Frequent | Native |
| *Megalopscyprinoides*Broussonet, 1782 | Buan-buan (Indo-Pacific tarpon) | X | | Infrequent | Native |
| *Oreochromismossambicus*Peters, 1852 | Tilapia | X | X | Infrequent | Introduced |
| *Poecilia reticulata* Peters, 1859 | Guppy | X | X | Infrequent | Introduced |
| *Trichopodustrichopterus*Pallas, 1770 | Three-spot gourami | X | | Infrequent | Introduced |

*Legend:* X – *present*

**Water Quality Parameters**

The selected water quality parameters, namely temperature, pH, dissolved oxygen (DO), and total suspended solids (TSS) were considered to be among the limiting factors for the survival of aquatic organisms particularly fishes [25]. In this study, it was found out that these parameters have changed significantly with regards to 2009 and 2019 measurements (Table 2). Most notable changes were observed in the DO level and the TSS concentrations.

**Table 2:** Measurements ofSelected water quality parameters

| Water Quality Parameters | Average values ± SE | | Significance ($\alpha = 0.05$) |
|---|---|---|---|
| | 2009 | 2019 | |
| Temperature ($^oC$) | 30.0 ± 0.2 | 26.9 ± 0.06 | Yes |
| pH | 7.0 ± 0.1 | 7.4 ± 0.03 | Yes |
| Dissolved oxygen (DO) (mg/L) | 32.67 ± 1.95 | 4.5 ± 0.27 | Yes |
| Total suspended solids (mg/L) | 0.67 ± 0.02 | 123.3 ± 9.12 | Yes |

## IV. Discussion

It was not surprising that all species found in Butuanon river during the conduct of the study were hardy species as they are already living in a harsh environment. The fish species present in the river are notable forhaving high levels of tolerance to unfavorable environmental conditions characterized by turbid and stagnant waters such as that of Butuanon river[26, 27, 28, 29, 30, 31]. Likewise, majority of these species are airbreathers, namely;*Anabas testudineus*[32], *Channastriata*[33], *Clarias macrocephalus*[34],and*Trichopodustrichopterus*[35], which under such condition when dissolved oxygen in the water is at or near critical level these species are still able to survive by breathing air directly from the atmosphere. Despite these adaptations, however,it is a major concern that an obligate airbreather, *A. testudineus*, *Megalops cyprinoides*, and *T. trichopterus*have disappeared.The disappearance of these fish species implied that the river is in its worst, if not critical, condition to support fish life, i.e. the water quality of the river is deteriorating.

As presented in the previous section, the selected water quality parameters for this study such as dissolved oxygen (DO), and total suspended solids (TSS) were below the water quality standards set by the DENR Administrative Order (DAO) No. 2016-08 even under Class C and Class D waters (Table 3).According to DAO 2016-08 water quality guidelines, Butuanon river is classified as Class AA water based on the give parameters.

**Table 3:** DAO 2016-08 Water quality guidelines for primary parameters

| **Water Quality Parameters** | **Water Body Classification** | | | | | **This Study** | |
|---|---|---|---|---|---|---|---|
| | **AA** | **A** | **B** | **C** | **D** | **2009** | **2019** |
| Temperature ($^{o}$C) | 26-30 | 26-30 | 26-30 | 25-31 | 25-31 | 30.0 ± 0.2 | 26.9 ± 0.06 |
| pH (range) | 6.5-8.5 | 6.5-8.5 | 6.5-8.5 | 6.5-9.0 | 6.0-9.0 | 7.0 ± 0.1 | 7.4 ± 0.03 |
| Dissolved oxygen (DO) (mg/L) | 5 | 5 | 5 | 5 | 2 | 32.67 ± 1.95 | 4.5 ± 0.27 |
| Total suspended solids (mg/L) | 25 | 50 | 65 | 80 | 110 | 0.67 ± 0.02 | 123.3 ± 9.12 |

These given parameters are important factors particularly for the survival of fishes in the river. For instance, the temperature is an important physical factor which have significant physiological impacts especially on ectothermic organisms like fish. Temperature level must be within the organism's tolerance range. For a tropical fish to grow, for example, the optimum water temperature must be between 25$^{o}$C– 32$^{o}$C [36], however they can still survive water temperatures within the tolerance limits of 23.9$^{o}$C and 32.2$^{o}$C [37]. In this study, regardless of the significant change in the temperature readings between 2009 and 2019, it cannot explain the disappearance of fish species in Butuanon river.

Conversely, an important chemical factor which have impact on the water quality and the organism's survival is the pH of the water. This parameter determines the alkalinity and/or acidity of the water. Changes in water pH likely trigger ion disruption and ammonia excretion in fish [38]. In the study of Ivoke et al. [39], fish die in very acidic water due to failure to regulate its internal ion content. Boyd [36], likewise noted that fish die at pH 4.0 and pH 11. Given this tolerance limits, the disappearance of fish species in Butuanon river is not due to change in the water pH since the readings between 2009 and 2019 is within the optimum range, i.e. pH 5.0 to pH 9.0 [36].

Another important requirement for the survival of the fish in the river is dissolved oxygen (DO). It is primarily needed by the fish during respiration. Oxygen saturation level of at least 5 mg/L will be enough for the survival of the fish in the river. Dissolved oxygen below 5 mg/L will bring the stress to the fish and levels below 2 mg/L will ultimately lead to fish kills [37]. In this study, the DO seems the plausible explanation for the gradual disappearance of fish species in Butuanon river as it is lower than 5 mg/L. The lowering of the DO is brought by the interactions of several contributing factors such as excessive amounts of organic matter, wastes, and high sedimentation rates[40] which results to shallowing of the river bed, among others. These contributing factors are persistentinButuanon river.

In connection to DO, another important water quality parameter, which can very helpful in explaining the disappearance of the fish species in Butuanon river,is the total suspended solids (TSS). In this study, TSS content of Butuanon river is increasing based on the 2009 and 2019 readings. These suspended particles have come from soil erosion, runoff, discharges, pollutants, stirred bottom sediments or algal bloom, among others [41] and has affected the turbidity of the water. It has been noted that fish exposed to high suspended solids will have massive physical damage to its gill structure leading to clogging, respiratory failure, and death [42].

Temperature influences all biochemical reactionsand, therefore, has a significant impact on thephysiology of an organism

## V. Conclusion

The disappearance of 42% of fish assemblage in Butuanon river generally is attributed to the declining water quality of the river as demonstrated particularly by the increasing total suspended solids (TSS) which has

an influence on the lowering dissolved oxygencontent of the riverin the last 10 years. The increasing TSS level, which is among the parameters used to determine the river's water quality, can be attributed to the unfettered human activities, including the improper and irregular disposal of garbage and wastes into the river.This ecological problem, i.e. pollution, is both natural and social issues and thus it should be looked at with atransdisciplinary and transgenerational perspectives. Thus, to rehabilitate Butuanon river, it is then highly recommended to prioritize social awareness through educating and disciplining the people, as well as strict implementation of the environmental laws and policies, in a regular and persistent effort.

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