Physico-Chemical, Biological and Anthropogenic-Related Attributes of Cagayan River Sub-tributaries in Nueva Vizcaya, Philippines

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Abstract: ***This is the first phase of an extensive research project regarding the status of water bodies in Nueva Vizcaya. It deals with water quality and biodiversity assessment, and identification of anthropogenic-related attributes of the Cagayan river subtributaries flowing in the province. In this specific phase of the study, the subtributaries assessed were the Aritao and Bambang rivers, following the Magat River main tributary course. Transect sampling sites were established and assessments were done twice. Water quality assessment was done by ocular inspection and laboratory analyses of the physico-chemical properties of water samples. Biodiversity survey was done by riparian zone assessment and taxon classification of the organisms found within and along the river areas. Anthropogenic-related attributes were identified by ocular inspection of evidences of human intervention. In order to establish links between the present and the past attributes of the rivers, information about the status of the rivers in the past were gathered through interviews with folks residing near the said rivers. Results revealed that the physico-chemical properties of both the Aritao and Bambang Rivers conform to the freshwater class B classification standards of the Department of Environment and Natural Resources (DENR). A number of organisms were classified under the taxa of aquatic plants, fishes, mollusks and macroinvertebrates. Both rivers showed evidences of anthropogenic intervention along the aspects of livelihood, infrastructure, waste-product and recreational factors. Information from interviews revealed that both rivers were richer in aquatic organisms years back compared to their present conditions. Findings will serve as starting point for the conceptualization of possible projects and drafting of local policies by the local government units and non-government organizations that may regulate the utilization of the aquatic resources to maintain the good water quality status of the rivers and to preserve the existing flora and fauna therein.***

Keywords: biodiversity, environmental health status, climate change, water quality, human footprints

1. Introduction

Climate change is a natural phenomenon that the society has to constantly cope with. It is in constant state of flux. The Intergovernmental Panel on Climate Change refers to climate change as any change in climate over time, whether due to natural variability or as a result of human activity [1]. Climate change was viewed as a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. A rapid shift of climate is induced by anthropogenic activities [2]. This rapid shift, such as a change within a century can disrupt the foundations of life on earth. Biodiversity loss and environmental health degradation are among the topmost adverse impacts of climate change.

The Philippines' climate is influenced by large-scale atmospheric phenomena that bring in substantial amounts of rains almost all year round. However, due to the uneven distribution of rain with respect to time and space and the occurrences of extreme events such as floods and droughts, the country's water resources have in the past experienced imbalances in supply and demand [3]. Occurrences of extreme climatic events like droughts and floods have serious negative implications for major water reservoirs in the country. Like many of the world's poor countries, the Philippines is one of the most vulnerable to the impacts of climate change because of its limited resources [4]. It is one of the world's megadiverse countries and is considered one of the biodiversity hotspots, too. The country therefore is not exempted from biodiversity loss. Globally, about 20% to 30% of species (global uncertainty range from 10% to 40%, but varying among regional biota from as low as 1% to as high as 80%) will be at increasingly high risk of extinction, possibly by 2100, as global mean temperatures exceed 2 to 3°C above pre-industrial levels [5].

From 1951 to 2006, records of the national weather bureau (PAGASA) showed that warming has occurred in the country [6]. Rising sea levels, one of the indicators that climate change is occurring, have also been observed to happen in five major stations (Manila, Legazpi, Cebu, Davao and Jolo). Annual mean sea level was observed to increase in Manila since 1960s while for the rest of the stations, sea level rise occurred in 1970s. In Manila, Legazpi, and Davao stations, an increase of almost 15 cm was observed from 1980-1989.

There were studies which have been conducted regarding the link between climate change and the Philippine forests and water ecosystems throughout the country. Most of the past researches focused on the mitigation potential of terrestrial ecosystems. A detailed review was conducted [7] regarding the link between climate change and the Philippine forests. Limited research suggests that dry forest types are the most vulnerable to climate change and potential adaptation strategies do exist but have not yet been adequately studied. Studies on the link between water ecosystems and climate change were mostly focused on the assessment of the current state of watersheds and watershed management in the Philippines along with the current policies and programs related to watershed management. It is estimated that at least 70% of the total land area of the Philippines belong to watersheds of varying sizes. Watersheds with areas of at least 100,000 ha referred to as river basins comprise more than 10 M ha of the watershed areas. These include areas inside and outside watersheds that are proclaimed as watershed reserves. Proclaimed watershed reserves refer to those watersheds that were specifically designated for various purposes such as domestic water supply, irrigation, hydroelectric power generation and multiple uses. Watersheds are valuable not only because of their water resources but also because of forests and other natural resources found therein. Management of watersheds is hence critical in promoting the sustainability of all the natural resources in the watersheds. Region 2 has 5 (119,261 ha) proclaimed watersheds and 16 (1, 637,887 ha) priority watersheds.

The Cagayan River is the longest river that runs in Region 2. It's major tributary that runs in Nueva Vizcaya is the Magat River. The sub-tributaries following this major tributary course are located in the towns of Sta. Fe, Aritao, Bambang, Bayombong, Bagabag and Diadi. With the extreme weather events experienced in the province such as too hot summer, prolonged cold months, strong typhoons, heavy rains, strong winds and unpredicted weather forecast, these river tributaries can give a picture of the impacts of climate change on water quality and biodiversity. Since comprehensive records on the status of these river sub-tributaries in Nueva Vizcaya are lacking, it is important to initiate an assessment of the physico-chemical, biological and anthropogenic-related attributes of the said rivers to serve as bases for establishing links between climate change and water ecosystems and for future environmental quality monitoring.

2. Methodology

2.1 Sampling and Collection

Sampling sites were established in the rivers: three in the Aritao River and two sites in the Bambang River. Three transect sites measuring 100m each were established per sampling site. Collection of water samples, biodiversity survey, and ocular inspection of anthropogenic-related factors were done in each of these transects. Geographical locations were identified using the Global Positioning System (GPS). Survey and collection were done twice, in August 8 and December 5, 2015.

2.2 Assessment of Physico-chemical attributes

The water bodies were assessed in terms of channel shape, color, odor, substrate, and the type of organic materials by ocular inspection. Measurements of the width (m) and depth (m) of the rivers were taken through the rolled meter. To determine flow rate (m^3/sec) and velocity (m/sec), a Styrofoam float was released unto the surface of the water body in a 1m line across the middle of the transect. The time (sec) for the float to reach the end of the 1m mark was recorded. Surface current velocity (m/sec) was calculated and the flow rate (m^3/sec) was computed as $R = WDaV$, where W = width of the transect; D = average depth at the middle of each transect; V = surface current velocity; a = constant as to the type of bottom (0.8 for rough and 0.9 for smooth). Temperature was measured using a thermometer. The pH was taken using the pH meter. Meanwhile, the refractrometer was used to determine the density (g/ml). The presence and concentration of the chemical species namely ammonia (ppm), nitrite (ppm), dissolved oxygen (mg/L), total dissolved solids (mg/L), total chlorine (ppm), iron (mg/L), and sulphate (mg/L) were determined using the Hanna Water Test Kit.

2.3 Assessment of Biological attributes

The riparian zone assessment was done by using the ecological survey key for verge and bank vegetation survey and percent bare soil estimation. Taxon classification of the macroflora and macrofauna surveyed and collected were done. These were photo documented and kept as herbarium specimens in the Center for Natural Sciences Research Laboratory of Saint Mary's University.

Table 1: Ecological survey key for verge and bank vegetation

Verge and Bank Vegetation		*Bank Vegetation Damages*	
Rating	Description	Rating	Description
Excellent	Vegetation on both sides of the river in excellent condition, leaves of the trees present from an extensive umbrella like structure or canopy. No evidence of human activities in the area.	None	No damage observed.
Average	Vegetation abundant on both sides of the river, umbrella like canopy is not intact but is in good condition. Some signs of disturbances observed, presence of trails or footpath.	Slight	Small cracks observed in one or two areas.
Fair	Vegetation clearly disturbed and moderately disturbed by grazing animals.	Moderate	Cracks and small bank collapses observed.
Poor	Vegetation land cleared on one or both sides of agriculture or farming or urban development. Plants have been trampled upon and uprooted; evidences of garbage around the area.	Severe	Extensive cracking and/or bank collapse exposed.

2.4 Assessment of anthropogenic-related attributes

Anthropogenic-related attributes were identified by ocular inspection of evidences of human intervention such as the presence of livelihood factors (i.e. fishing, irrigation channels); infrastructure factors (i. e. houses, schools, industrial buildings); waste-product factors (i. e. garbage, plant/ animal debris); and, recreational factors (i. e. cottages, picnic grounds).

2.5 Gathering of information on previous status of the rivers

Information was gathered through interviews from the local folks living nearby the rivers and from some barangay officials.

3. Results and Discussion

3.1 Physico-chemical, biological, and anthropogenic-related factors

Table 2: The physico-chemical attributes of the assessed river sub-tributaries

Physico-chemical Attributes	*Aritao River*	*Bambang River*
channel	U-shape	U-shape
color	light brown to brown	green
odor	stale fish/ wet earth	stale fish/ wet earth
substrate	gravel and sand	cobble and sand
organic materials	muck-mud	muck-mud
width (m)	24	45
depth (m)	25	20
flow rate (m^3/sec)	2	3
velocity (m/sec)	9.5	13
temp	27	29
pH	7.7	8
density (g/ml)	1	1
ammonia (ppm)	0.5	0.5
nitrite (ppm)	0.01	0
DO (mg/L)	7.15	7.05
total chlorine (ppm)	0.32	0.1
iron (mg/L)	0.05	0.09
sulphate (mg/L)	65	130
total dissolved solids (ppm)	0.22	0.22

In terms of physical attributes, the Aritao River is a U-shaped channel section, with light brown to brown water, stale fish/ wet earth odor, gravel and sand river bottom and with muck-mud organic materials. It has an average width of 24m and an average depth of 25m. Its average velocity and flow rate are 9.5 m/sec and 2 m3/sec., respectively. Surface water temperature is 27C at a pH of 7.7 and a density of 1g/ml. The Bambang River is also a U-shaped channel section, with green water, stale fish/ wet earth odor, cobble and sand river bottom, and with muck-mud organic materials. It has an average width of 45m and an average depth of 20m. Its average velocity is 13 m/sec and its average flow rate is 3 m3/sec. Surface water temperature is 29C at a pH of 8 and a density of 1g/ml.

In terms of chemical attributes, the Aritao River is described with the following average values: 0.5 ppm ammonia, 0.01 ppm nitrite, 7.15mg/L dissolved oxygen, 0.32 ppm total chlorine, 0.05ppm iron, 65mg/L sulphate, and , 0.22ppm total dissolved solids. The Bambang River on the other hand has the following average chemical attributes: 0.05ppm ammonia, 7.05mg/L dissolved oxygen, 0.1 ppm total chlorine, 0.09 ppm iron, 130 mg/L sulphate, and 0.22ppm total dissolved solids. Nitrite was not detected.

There are some striking properties of the two sub-tributaries which are pointed in this study. The Aritao River water parts were mostly light brown to brown. This color can be attributed to the quarrying activities seen in the area, most especially at sites 1 and 2. Eroded parts of the mountain near the Aritao River in site 3 contributed also to the brownish color of the water. Most water parts of the Bambang River on the other hand were greenish. This is because of the bulk of algae observed in the water bodies. These results on the color of water are of natural causes, hence, both rivers conform to the Philippine standards for freshwater quality criteria [8]. The average width also of the Bambang River is far wider than that of the Aritao River. The water can flow into a wider area because of the absence of sand and gravel bulks from quarrying activities unlike those in the Aritao River. In addition, houses in the sites surveyed for the Aritao River were closer to the river banks compared to what was observed in the Bambang River. The pH of the water samples from both rivers (7.7 and 8) are within the range of 6.5-8.5, the normal range of pH based on the Philippine standards for freshwater quality criteria [8]. This is the desirable range for fish production. Hence, both rivers have waters acceptable for fish production. This gives the impression that both rivers can still be a habitat for freshwater fishes. Though there is no set criterion for ammonia concentration for Philippine freshwater, the 0.5 ppm detected from both rivers is higher than the standard for Malaysian freshwater, 0.3 ppm [9], an Asian country which may somehow have similar geographical set up with the Philippines. Ammonia is an initial product of the decomposition of nitrogenous organic wastes and respiration. Nitrogeneous organic wastes come from uneaten feeds and excretion of fishes. High concentrations of ammonia causes an increase in pH and ammonia concentration in the blood of the fish which can damage the gills, red blood cells, affect osmoregulation, reduce the oxygen-carrying capacity of the blood and increase the oxygen demand of tissues [10]. This study however cannot establish that the presence of only a few fishes in the two rivers may be due to the quantified ammonia concentration because of the lack of a standard concentration. Just like ammonia, there is no set criterion for nitrite concentration for Philippine freshwater, but the standard for Malaysian freshwater is also 0.3 ppm [9]. The Aritao River was found to have a very minimal concentration of 0.01 ppm, a near zero value, and nothing was detected from the Bambang River. Hence, nitrite is not a significant chemical factor in possibly affecting aquatic life in both rivers. The Dissolved Oxygen (DO) minimum standard concentration for Philippine freshwater [8] is 5.0 mg/L. Both rivers exceeded this value (7.15 and 7.05). Dissolved oxygen is needed by fish to respire and perform metabolic activities, as well as with the other organisms like the bacteria, phytoplanktons, and zooplanktons. Optimum levels can result to good production yield while low levels can be linked to fish kill incidents. Levels of dissolved oxygen can be increased through mechanical aeration, considerable wind, and wave action and the presence of aquatic plants and algae [9]. As observed in the sampling sites in the Aritao River, the quarrying activities may be factors in increasing the dissolved oxygen. In the sampling sites in the Bambang River, the presence of numerous algae may be considered factors in this level of dissolved oxygen. Total dissolved solids (TDS) refer to any matter dissolved in water such as bicarbonate, sulphate, phosphate, nitrate, calcium, magnesium, sodium and organic ions [9]. These are important in sustaining aquatic life but can result to damage in organism's cell [11]. There is no set criterion for TDS for Philippine freshwater. But the value 0.22 ppm is a minimal TDS concentration for both the river tributaries. The measured concentration may be due to the chemical composition of fertilizers leached into the river systems by the irrigation channels observed in the river sites and also from the components of detergents disposed into the rivers from laundry activities. Possible contributors are the detected concentrations of total chlorine (0.32 and 0.1 mg/L), iron (0.5 and 0.09mg/L) and sulphates (65 and 130 mg/ml).

Table 3: Biological attributes of the assessed river sub-tributaries

Attribute	*Aritao River*	*Bambang River*
Verge vegetation	Poor, Fair to average	Fair
Bank vegetation	Fair with slight to moderate bank damages	Poor with severe to moderate bank damages
Bare soil	40-80%	40-80%
Fish	3	3
Aquatic Plants	40	30
Mollusks	5	5
Macroinvertebrates	10	6

In terms of the biological attributes, the Aritao River was found to be of poor to fair to average verge vegetation and fair bank vegetation with slight to moderate bank damages; while the Bambang River was assessed to be fair in verge vegetation and poor in bank vegetation with severe to moderate bank damages. Both rivers were assessed to be with 40-80% bare soil. A few taxa were determined and identified. There were 40 varied terrestrial (from the river banks) and aquatic plants collected in the Aritao River and 30 from the Bambang River. Most of these plants are grasses and are almost similar to both rivers. Some are aquatic like water lilies. Three fishes were found both in the two rivers. These are *tilapia, million fish, dalag*. Five molluscs were identified namely golden *kuhol, native liddeg, binnek*, *agurong* and *kuskusileng*. A number of macroinvertebrates (ten in Aritao River and six in Bambang River) were also classified.

The results of the biological survey revealed the presence of the four taxa surveyed. Hence, the water bodies are indeed habitable for the growth and reproduction of the organisms. However, an alarming result is that there are only a few of the aquatic fauna, particularly the fish and mollusk taxa which are said to be natural communities of typical rivers.

Table 4: Anthropogenic-related attributes of the assessed river sub-tributaries

Attribute	*Aritao River*	*Bambang River*
livelihood factors	fishing activities irrigation channels quarrying activities	fishing activities irrigation channels quarrying activities
infrastructure factors	Houses school	houses
waste-product factors	garbage/plastics plant/ animal debris laundry activities	garbage /plastics plant/ animal debris
recreational factors	picnic grounds bathing activities tire marks human footprints food leftovers	picnic grounds bathing activities tire marks human footprints food leftovers

The two rivers were observed to have similar attributes in terms of evidences of human activities. In terms of livelihood factors, the two rivers indeed are sources of livelihood for the people. During the survey, there were people seen who were catching fish using nets; there were also fishing traps seen at the middle parts of both rivers. Some of the *tilapia* which was caught was actually the young ones. Most of the sides of the banks were rice fields, hence irrigation channels were evident. There were parts of the river where the flow of water was redirected into the rice fields. Piles of sand and gravel were observed, indicating quarrying activities, most especially in the sampling sites of the Aritao River.

For infrastructure factors, there were houses situated near the two rivers. However, those in Aritao were nearer the river banks than those in Bambang. There was also a school near sampling Site 1 of the Aritao River. These infrastructures may not necessarily be putting much pollution into the rivers unlike factories, but household pollutants can add up to increasing unwanted chemical species into the water bodies.

For the waste-product factors, garbage, mostly plastics and foils, and plant and animal debris were observed in both the two rivers. There were also some who were seen washing clothes in the Aritao River. Activities like these can then deposit chemicals into the rivers, which in turn may affect aquatic life if not done in moderation.

The two rivers also serve as areas for recreation like picnics. There were evidences of picnic grounds, leftover food, human footprints, and tire marks. In both rivers, there were also some children seen during the survey who were taking a bath.

3.2 Narrative on the previous conditions of the River based on interviews: how human footprints impact the physical conditions of the rivers

Rivers and streams have always been important to human history as they "provide the lifeblood to the ecosystem, the source of water for drinking and irrigation as well as home to life forms particularly fish that humans eat" [12]. In great civilizations, rivers were transportation routes and conduit through which much of commercial activities have taken place. The Magat River is the largest tributary with an estimated annual discharge of 9,808 million cubic meters. It lies in the southwestern portion of the basin, stretching approximately 150 kilometers from Nueva Vizcaya down to its confluence with Cagayan River about 55 kilometers from the river mouth. The river traverses four provinces: Nueva Vizcaya, Quirino, Isabela and Cagayan. The river drains a fertile valley that produces a variety of crops, including rice, corn, bananas, coconut, citrus and tobacco. Historically, the Magat River has brought both blessings and disasters to the people of Nueva Vizcaya. The eastern bank of the Magat was sandy soil, the western being clayey and the most productive [13]. It was in the latter area where most of the towns of the province were located as they are today. A report from the Philippine Commission dated 1908 speak of a terrible storm that hit the province in September 26, 1906 which destroyed the Vicente Irrigation system since the floods washed more than a thousand feet of the river bank practically watering all the fields of Solano and Bayombong and their barrios. The same report noted the rise in the rivers during the rainy season that eventually threatened the safety of the people of Bayombong. Such was the extent of damage brought by the river that the local government had to seek expert advice to arrive at a plan necessary to control the rivers. A hefty sum was appropriated by the Philippine Congress for the construction of a defense at Bayombong and Bambang against the yearly onslaught of the Magat River [14]. The people of the province had "comparatively high-grade civilization among the Christian inhabitants" [15]. However, the absence of bridges and real roads at that time presented a problem particularly during the rainy seasons. Turnbull recounts: The trail to Bambang for instance crossed the Magat River near Bayombong, and when the waters overflowed, raging torrents hampered not just travel but economic activity as well. Trails were interrupted by innumerable swollen streams, making them impassable. Strong river currents also made control of rafts difficult such that Bayombong, Bambang, and Aritao could not communicate with each other. Such historical tidbits validate the locales' observation that the rivers of Bambang and Aritao used to be powerful because of their flow and depth. Across the years however, human activities have somehow altered and impacted the natural variability of the river flows. Human footprints [16] like livelihood, infrastructure, waste-products, and recreational factors in some way had an impact on the quality of water and the on the aquatic life that it protects. Locales recall of a time when the rivers were narrow but deep and the water was clean. Accordingly, the rivers were not far from their current location, but their course was in the middle. A key informant said that back then (about 20 years ago) in the area where the river and the creeks met was a good place to swim. The course of the water was straight, with moderate flows except when the heavy rains come or the typhoons cause the water levels to rise. On either side of the rivers were medium-sized trees such as *bitnung, alukun, damortis* and *tanubong*, healthy vegetation that kept the banks from eroding. Shrubs, grasses *(lidda* and *tanglad)* were numerous; and a variety which they called *balaiba* could be obtained from the river bed which the informants said could be gathered and prepared into fresh salad garnished with tomatoes. Such physical endowments were conducive to aquatic life, which they described as plentiful. Freshwater shrimps, *ayungin, paltat* (the native variety), as well as mollusks like *agurong, liddig, kus-kusiling* abound. It was then that fishing was integral to the everyday life of the townsfolk. This was done either by hook and line or through fish traps (*talakib, bisbisile*) and was done not only for consumption but also for trade. According to a folk resident, (Interview, 2015), if one were to throw a hook in the river, one can get a lot of big fish. Informants also look back to a time when they would gather mollusks from the rivers, sometimes twice in a day, as they were plentiful. One informant narrates that she and her sister in law would gather as much and sells them in the market (Interview with Antonia G. Beras, 2015). They also recall those times when the mollusks were big and tasty and ever present at the rivers. When informants were asked why they refer to these activities as though they were only of the past, their answers echo the physical conditions of the river and how anthropogenic activities have disturbed its natural course as well as the people's living conditions. A remarkable change according to them is the fact that there are fewer fish to catch both in variety and number. An informant said, "You'd be lucky if you could catch five. In the earlier years, you did not have to seek them painstakingly since you could see them clearly from the surface. Some of the fishes would get trapped in the stones, and these were big ones" (Interview, 2016). They attribute the diminishing number of fish to the altered course of the river, as well as to the manner by which fishing is done by some nowadays. Since the fish are hard to come by, some would resort to electrifying them. Besides causing accidental deaths, catching fish by electrocution can badly influence the ecological niche because it kills aquatic life of all sizes, including eggs. They also attribute it to premature harvesting. One informant related that the Provincial government used to release thousands of fingerlings into the streams but they do not reach maturity due to human intervention. But the diminished number in fish population is not only because of electrofishing, but more because inhabitants near the river banks or from upstream throw their garbage into the water. Evidences of plastics, plant and animal debris abound. One of the researchers has had personal experiences when she would notice carcasses from rotting dogs float by creeks. The implication here is rather clear since "surface water plays a key role in the transmission of pathogenic agents" [17]. Direct deposition to steam channels affects water quality. That informant would now have misgivings about eating mollusks and fish obtained from the river is indication of the effect that said organisms have had on aquatic life:

> *"Iddi a ket haan ka nga adudua nga kanen ida ta napudaw ken nalines da pay; ngem ita, nangisit da ket maamak ka pay nga sidaen ida"*
> (You wouldn't hesitate to eat them before because the shells are clean and transparent; today however, they are black in color and you would have doubts tasting them")

Some also use the lands nearby for the grazing of animals like cows and goats or putting up poultries and piggeries. Again the possibility of these wastes being disposed directly into the waters is strong. A cause-effect relationship comes into play with regard other human activities. The state and status of the river is compounded by the presence of irrigation channels, as well as the presence of houses and schools nearby. Again, informants said that there had been quite a number of houses along or near the river banks but the swelling of the rivers during heavy storms have caused them to relocate. Still, once the waters have receded, some would come particularly when they see the place to be vacated. Concrete reinforcements have also been placed here and there where the waters flow; some families however, have squatted on them, with little regard to its effect on their safety. There is the matter of waste disposal that has to be dealt with here. While inhabitants claim that they have been more vigilant with regards the care of the river, since a law (RA 9003-Solid Waste Management Act) has been passed and implemented prohibiting the throwing of trash into the river, they allege that some people cannot be prevented unless they are directly caught. They also think that the garbage comes from elsewhere (upstream) and that pollutants actually are from non-point sources (plastics, diapers). Nonetheless, this contributes to water clogging, "since litter is logically either floating litter that pollutes the surface water or sinking litter which pollutes the bottom of the river" [18]. While floating litter may easily be addressed by literally picking them up, it is the latter that the people have to be more wary about since the "accumulation of sinking litter sometimes modifies natural habitat of fish and water plants" [18]. Moreover, the lands adjacent to the rivers are also agricultural lands and tillage of land has been known to cause "changes in the infiltration and runoff characteristics of the land surface, which affects delivery of sediment to surface-water bodies" [18]. In a way, too, plowing intensifies soil erosion that increases the amount of different substances entering the rivers. While this may happen only during inclement weather, still, the possibility of seepage of agricultural wastes into the water is there. Key informants validated this when they said that "pesticide and insecticides led to the death of fishes in the river". Irrigation systems in the form of canal linings also get affected by water flow discharge from farming areas; as mentioned fertilizers or pesticides washed out to the river result in river/riverbed/sediment contamination [16]. Moreover, the sides of the river can erode if farming is done too close to the river's edge and if humans walk along paths which follow a river. Back in time the rivers had natural attraction because its clean and serene waters beckon inhabitants for picnics and a swim. Many families have collective memories of the fun spent at the waters and the river banks during vacation time or on holidays. But again human activity like quarrying has affected the direction and the course of the river making the beds dry up during the summer time. Moreover, dikes and river banks easily erode which often destabilize bed and banks and result in dramatic channel readjustments [19]. For example, human activities that accelerate stream bank erosion, such as riparian forest clearing or instream mining, cause stream banks to become net sources of sediment that often have severe consequences for aquatic species. Anthropogenic activities that artificially lower stream bed elevation cause bed instabilities that result in a net release of sediment in the local vicinity. Unstable sediments simplify and, therefore, degrade stream habitats for many aquatic species. Few species benefit from these effects. Admissibly, locales seem to think that they are doing conservation efforts and adhere to their personal mandates of caring for their environment. But the physical evidence point to the contrary. Until, they are made to realize that human activities pose danger and lessen the functionality of the rivers, the call to environmental protection might fall on deaf ears.

4. Conclusions and recommendations

The Aritao River and Bambang River are classified as Class B Freshwater Systems. Their physico-chemical properties are still in good condition to support aquatic life. A number of aquatic plants, fish, mollusks and macroinvertebrates were observed inhabiting the rivers. Evidences of anthropogenic-related activities were observed. Both rivers are capable of self-sustainability. The problem on a few number of organisms seen is not actually a concern of water pollution brought about by contaminants that are really drastic to aquatic life, but a concern on resource utilization by people in the area and the attitude of the people towards the care of the said rivers. There might have been activities of over collection of fishes and mollusks. The quarrying activities may have also disturbed the spawning grounds of the aquatic fauna. Irresponsible throwing of garbage and leaving picnic non-biodegradable materials also may eventually contaminate water quality. Hence, this study may serve as a starting ground for the local government units covering the said rivers, as well as the non-government sectors involved in environmental campaigns, to start with projects that can maintain a good status of the rivers and draft local policies that may regulate the utilization of the aquatic resources. Otherwise, the few existing flora and fauna of the rivers determined in this study may not be able to abundantly reproduce and with the very quick shift in climatic conditions, may result into extinction.

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