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REGRESSION ANALYSIS OF THE BALILI RIVER'S BIOLOGICAL TO PHYSICO-CHEMICAL CHARACTERISTICS

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ABSTRACT

The study determined the interrelated physico-chemical characteristics of the Balili River water system and the regression analysis of the dissolved oxygen and biological oxygen demand with the derived interrelated physico-chemical factors of the Balili river water system. Secondary data regularly monitored by the Environmental Management Bureau of the Department of Environment and Natural Resources, Cordillera Administrative Region was used in the Study. Factor and Regression analyses were the statistical tools used in the study.

There were four derived interrelated physico-chemical factor of the Balili River water system. These factors are the following: F1: Physico-chemical Factor; F2: pH-Conductivity-cadmium-phosphate Factor; F3: Temperature-Coliform Factor; and F4: Lead-TSS Factor. The Dissolved Oxygen (DO) of the Balili River water system was correlated to the four factors derived as shown by the equation: DO = 8.242 – 0.26F1 + 0.18F2 + 0.084F3 – 0.069F4, but not significantly correlated. The Biological Oxygen Demand is correlated with the four derived factors shown in the following equation: BOD = 51.643 + 0.74 F1 – 0.122F2 + 0.143F3 + 0.16F4. The first factor was significantly interrelated with oxygen demand while the other three factors were not. It is recommended that water treatment procedures should be undertaken to improve the dissolved oxygen and oxygen demand of the Balili River water system.

Keywords: *Balili river water system, dissolved oxygen (DO), biological oxygen demand (BOD)*

INTRODUCTION

Rivers and creeks are motors of petro genetic cycle of the Earth, transporting water and sediment down slope to lakes and oceans. Along the way, sediment may be deposited, only to be eroded later during floods and transported farther along the system. Dynamic processing of sediment in the ever-changing river environment separates grains according to density, size, shape and resistance to weathering. Higher density and larger grains are found in high-energy environment near river channels. Lower density, smaller and plate-shaped sediment grains are found in low-energy regions such as meander cut-offs and flood plain, where water velocity is minimal or flow is absent. This natural processing, which sorts sediments and minerals according to their physical properties, serves as a mechanism by which potentially valuable earth deposits are concentrated to a particular point or area.

Water temperature is a vital physical characteristic of rivers and streams. Temperature will range greatly depending on the time of year, time of day, weather conditions and the flow rate of the stream or river. It is one determinant of the diversity and abundance of aquatic fauna and flora. It is a key variable responsible for shaping the ecology of aquatic habitats. Temperature can both directly and indirectly impact inhabitants of aquatic environments. Temperature indirectly affects animals by controlling dissolved oxygen concentrations (the capacity of water for holding

dissolved oxygen decreases with increasing water temperature). Temperature directly affects the physiology of plants and animals controlling activities, metabolism, growth and reproduction. pH is used universally to express the intensity of acid or alkaline conditions of a solution. It is a symbol for hydrogen ion concentration. As the pH decreases, water becomes more acidic. Conductivity is the ability to conduct electricity. Water conducts electricity because it contains dissolved solids that carry electrical charges. For example, chloride, nitrate and sulphate carry negative charges, while sodium, magnesium and calcium carry positive charges. These dissolved solids affect the water's ability to conduct electricity. Therefore, measuring the conductivity of the water indirectly indicates the amount of total dissolved solids (TDS) in the water.

Analysis of dissolved oxygen is extremely important in determining water quality. It is a measure of the ability of surface waters to support aquatic life (Beta-a *et al*., 2000). Total suspended solids are the amount of undissolved solid particles in a litre of water that will not pass through a two-micron filter and is expressed in mg/L. High concentrations of suspended solids lower the ability of the water to support aquatic life due to reduced light penetration affecting plant photosynthesis and the production of food and oxygen. Total dissolved solids are the sum of the cations and anions in the water. These solids consist of calcium, chlorides, nitrate, phosphorus, iron, sulfur and other ion particles that will pass through a filter with pores of around two-microns (0.002 cm) in size (Batang-ay, 2010). The primary source of TDS in receiving waters are organic sources, industrial waste and sewage, agriculture run-off, leaching of soil contamination and point source from water pollution from industrial and domestic sewage. Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions. It is a measure of the approximate quantity of dissolved oxygen that will be required by bacteria to stabilize organic matter in wastewater or surface water. It is a semi-quantitative measure of the wastewater organics that are oxidizable by bacteria. All heavy metals exist in surface waters in colloidal, particulate and dissolved phases, although dissolved concentrations are generally low. The colloidal and particulate metal may be found in 1) hydroxides, oxides, silicates or sulfides or two) adsorbed to clay, silica or organic matter. The soluble forms are generally ions or unionized organo metallic chelates or complexes. The solubility of trace metals in surface waters is predominately controlled by the water pH, the type and concentration of ligands on which the metal could adsorb and the oxidation state of the mineral components and the redox environment of the system.

Escherichia coli is a type of fecal coliform bacteria that comes from human and animal wastes. *E. coli* measurements are used to determine whether fresh water is safe for recreation. Disease-causing bacteria, viruses and protozoans may be present in water that has elevated levels of *E. coli*.

But as people flourished, so has the deterioration of the environment they were in. Now that humans live in a modern civilization where technology is evolving at an exponential rate, these rivers are now maybe taken for granted. Rivers are effective waste disposal and recycling agent however, if this function is abused, there are consequences, which are usually undesirable, that could take place. The population explosion is targeted as the main culprit which is probably the only logical explanation. When there were less people, the rivers were thriving with flora and fauna. But as soon as there was a rise in the population, the rivers seem to have been suffocated by too much human activity. Suffice it to say that since time immemorial, we have been dependent on these rivers. But now is the time when the river is depending on us. Such is the case of the Balili River.

Population rise could not be curtailed in an instant. The aim now is to educate the population. By bringing to them awareness and reality of the status of our rivers. Benguet State University is one of the front runners in the Balili River Rehabilitation Program. Together with other agencies, the community and even employees and students of BSU are walking hand in hand in the attainment of the objectives of this program.

Given these facts, the researchers were motivated to study the relationship of Physico-Chemical characteristics and microbe content of Balilli River which is the main tributary of the town

of La Trinidad.

Research and follow-up have to be conducted regularly to check and investigate possible focal points in the rehabilitation of the Balili River. Factors affecting the present condition of the river could be taken into consideration in the establishment of processes/activities to help in the revitalization of the Balili river water system. This study could contribute in solving the problem of water pollution along this river and can provide important information to affected communities and institutions.

Conceptual Framework

The study was based on the concept that if measurable interrelationship of selected Physico-Chemical characteristics and microbe content of the Balili River water system could be determined, remedial measures can be formulated to help in the revitalization of the river. To bring about the concept the study intended to determine the interrelationship of selected Physico-Chemical characteristics and microbe content of the Balili River.

The independent variables of the study were the following selected Physico-Chemical characteristics and coliform content of the Balili River: Water Acidity, conductivity, temperature, total dissolved solids (TDS), total suspended Solids (TSS), oxygen, cadmium, copper, lead, mercury, zinc, phosphate, ammonia, total coliform and fecal coliform contents. From the data to be collected the interrelationship of selected Physico-Chemical characteristics and coliform content of the Balili River water system would be determined and the corresponding effect of this the dissolved oxygen (DO) and biological oxygen demand (BOD) of the water. These were the dependent variable of the study.

Objectives

The expected output of the study are interrelated factors among the selected physico-chemical and coliform characteristics of Balili River water system and regression correlation of interrelated factors among physico-chemical and biological oxygen demand (BOD) and dissolved oxygen (DO) characteristics of Balili River water system.

The paradigm (Figure 1) shows the coverage and direction of the study

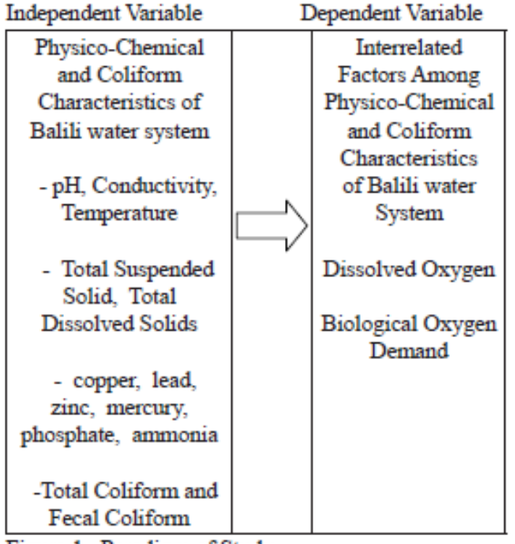

Figure 1. Paradigm of Study

MATERIALS AND METHODS

Data Collection

The selected physico-chemical and Coliform characteristics were based on the secondary data regularly collected by the Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR), CAR. The following physico-chemical and coliform characteristics were considered in the study: pH, conductivity, dissolved oxygen (DO), temperature, biological oxygen demand (BOD), total suspended solids (TSS), total dissolved solids (TDS), cadmium, copper, lead, zinc, mercury, ammonia, phosphate, total coliform and fecal coliform contents. Data collected by EMB were those gathered from 2010 to September of 2013. Samples were collected quarterly during the months of January, April, July and October. There were three sampling stations considered: along the Trancoville Bridge area, the Chinese Temple Bridge area and the bridge at Capitol, Km. 6 La Trinidad.

Statistical Analysis

The following statistical analyses were used:

1. Factor Analysis determined the interrelated

factors among the physico-chemical characteristics as well as the coliform content of the Balili River water system.

2. Linear regression correlation determined the correlation of the interrelated factors of the physico-chemical characteristics and the biological oxygen demand and the dissolved oxygen of the Balili River water system.

All hypotheses of the study was tested with the afore stated statistical measure at 0.05 level of probability.

RESULTS AND DISCUSSION

The interrelated factors among the selected physico-chemical characteristics as well as microbe content of the Balili River water system is presented on Table 1. Table indicates that there are interrelated factor among the physico-chemical and coliform characteristics of the Balili River water system. The Physico-Chemical Factor includes the water's temperature, total dissolved solids TDS), copper, zinc, mercury, phosphate and ammonia content. The factor loadings indicate that a combined significant increase in the total dissolved solids (TDS), copper, zinc, mercury, phosphate and ammonia of the water would have a corresponding significant increase in the water temperature.

The second factor included the pH, conductivity, cadmium and phosphate contents. Increase of one of the said parameters would correspond to an increase of the other. This implies that the increase in cadmium and phosphate content in the river could correspondingly increase the acidity and conductivity of the water.

The third derived factor was the temperature-coliform factor. A significant increase in the total coliform and fecal coliform of the water would mean a corresponding increase in the water's temperature.

The last derived factor was the lead-total dissolved solid factor. Increase in lead content of the water show also an increase in the total suspended

Table 1. Interrelated Factors among Selected Physico-Chemical and microbe Characteristics of the Balili River water system (Rotated)

Component	Physio-Chemical Characteristics	Factor Loading
1. Physico-Chemical Factors	Temperature	0.514
	Total Dissolved Solids	0.817
	copper Content	0.655
	zinc Content	-0.741
	mercury Content	0.552
	phosphate Content	0.646
	ammonia Content	0.798
2. pH-Cond-Cd-Phosphate Factor	pH	0.741
	Conductivity	0.562
	cadmium Content	0.814
	phosphate Content	-0.529
3. Temp-Coliform Factor	Temperature	0.430
	Total Coliform	0.874
	Fecal Coliform	0.838
4. Pb-TSS Factor	Lead	0.792
	Total Suspended Solids	0.896

solids (TSS) of the water. This indicates that possible source of the Lead content of the water is the total suspended solids (TSS) found in the water.

The linear regression correlation of interrelated factors among physico-chemical and coliform characteristics and the biological oxygen demand (BOD) of Balili Water System is presented below. The corresponding combined contribution of the four factors to the dissolved oxygen of the water as shown in the equation implies that there are combined effect of the four factors to the dissolved oxygen (DO). The dissolved oxygen (DO) would decrease by 26% of the Physico-Chemical content,

6.9% of the pH-Cond-Cd-Phosphate Factor and increase by 18% Temp-Coliform Factor and 8.40% Pb-TSS Factor. Combined effect of the four factors are observed but the effect is not significant as shown by the p-values computed which were all greater than the 0.05 level of significance.

DO=8.242-0.267F1+0.187F2+0.084F3- 0.069F4
0.000 >0.05 >0.05 >0.05 >0.05

The result would collaborate with the study of Degyem *et al.* (2010) where DO content was very low at Tabangaoen tributary pH were slightly alkaline.

The biological oxygen demand (BOD) measures the quantity of oxygen used by microorganisms in oxidizing organic matter. When the BOD of the water is high, this implies that there is a high organic loading in the river and a big volume of various pollutants are present in the river.

The equation below shows the combined effect of the four derived factors to the biological oxygen demand (BOD) of the river's water. The regression equation indicates that there is a corresponding effect of each factor to the biological oxygen demand (BOD). The biological oxygen demand (BOD) of the water increases for every increase of the physico-chemical factors, temp-coliform factor and Pb-TSS factor; and a corresponding decrease in pH-Cond-Cd-Phosphate Factor.

BOD = 51.643 + 0.747F1-0.122F2+0.143F3+0.16F4
0.000 0.0000 >0.05 >0.05 >0.05

The regression equation indicates that the biological oxygen demand (BOD) of the water would increase by 74.7% of the combined presence of total dissolved solids, copper, zinc, mercury, phosphate, ammonia and temperature of the water. Physico-chemical factor is the only factor that has a significant effect on the biological oxygen demand (BOD) of the water. The BOD content also decrease by 12.20% of the pH-Cond-Cd-phosphate content. Further decrease of BOD concentration is observe by 14.3% of temp-coliform concentration and 16% Pb-TSS.

The biological oxygen demand (BOD) of the water may not show significant relationship with the coliform content of the water which are at a very high level of concentration but from the derived factors shown in Table 1, the coliform content is significantly interrelated to the water temperature.

CONCLUSIONS AND RECOMMENDATIONS

There are interrelated physico-chemical and biological characteristics of the Balili River water system. The temperature, total dissolved solids, copper, zinc, mercury, phosphate and ammonia are considered as one factor. The second factor included pH-conductivity-cadmium and Phosphate factor; the third factor comprise the coliform-temperature factor and the last factor included the lead-total suspended solid factor.

There is no significant relationship of the derived factors to the dissolved oxygen (DO) of the Balili River water system.

The derived physico-chemical factor showed significant relationship with the biological oxygen demand (BOD) of the Balili River water system.

Continuous monitoring of the physico-chemical and biological parameters of the Balili water is recommended to detect improvement of the water system.

Similar research using the larger time frame of physico-chemical and biological characteristics data is recommended.

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