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Physico-Chemical Characterization of Layawan River

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Abstract:*This study aimed to assess the hydrobiological characteristics of Layawan River based on the standards set by the Department of Environment and Natural Resources (DENR) on the physico-chemical parameters such as phosphates, total suspended solids, pH and temperature, as well as total coliform.Descriptive normative method of gathering data was done with the aid of chemical, biological and physical laboratory analyses. Temperature and pH were measured directly on the field. Water samples for the other physico-chemical parameters and total coliform count were brought to the laboratory for analysis. Inferential statistics such as T-test and Chi-Square (χ^2) test were applied to determine the significant differences of the values obtain between seasons.Results of the study revealed that physico-chemical parameters and total coliform were within the DENR standard categorizing Layawan River as Class A water regardless of season. Layawan River therefore could be a source of water supply provided complete treatment like coagulation, sedimentation, filtration and disinfection are done in order to meet the National Standards for drinking water (NSDW). Moreover, the river is also a good place for recreational activities like bathing, swimming and skin diving.*

Keywords:*coliform,Layawan River,phosphates,physico-chemical characterization, total suspended solids*

I. Introduction

Rivers are of immense importance geologically, biologically, historically and culturally. They are critical components of the hydrological cycle, acting as drainage channels for surface water - the world's rivers drain nearly 75% of the earth's land surface. They provide habitat, nourishment and means of transport to countless organisms; their powerful forces create majestic scenery; they provide travel routes for exploration, commerce and recreation; they leave valuable deposits of sediments, such as sand and gravel; they form vast floodplains where many of our cities are built; provides power much for the electrical energy. Rivers are also important for farming because river valleys and plains provide fertile soils. However in agricultural areas the extensive use of phosphates and nitrates as fertilizers may result in other problems. Entering rivers via rainwater runoff and groundwater seepage, these chemicals can cause eutrophication. This process involves a sharp increase in the concentration of phosphorus, nitrogen, and other plant nutrients that promotes the rapid growth of algae in sluggish rivers and a consequent depletion of oxygen in the water.

According to [1] water quality data provides baseline information, helps identify trends or changes in water quality overtime, and aids scientists in investigating problems. [2]added that water quality is impossible to measure directly, but using the physico-chemical parameters such as: phosphates, total suspended solids, pH, temperature; and total coliform,indicatethe state of water quality. Significantly, phosphatedeposits in the river systems contain significant amounts of naturally occurring uranium. Phosphates concentration in aquatic systems is primarily from surface runoff of agricultural or landscaped areas which have received excess phosphate fertilizer. These levels of phosphates can be a culprit of eutrophication which is harmful to fishes which is a source of man's food [3]. On the other hand, [1] in his study concluded that the fecal coliform concentrations were the biggest contributor to poor water quality in the lower Nooksack River among the constituents monitored.However,[5] in Kentucky one of the biggest sources of water pollution was suspended solids.

Layawan River runs all the way from Mt. Malindang, Misamis Occidental, Philippines and continued its way to Sergio Osmeña, Zamboanga del Norte down to Polanco, Zamboanga del Norte where it merges with the Dipolog City River. It is one of the main sources of sand and gravel in Zamboanga del Norte. It is also used by nearby communities as a place for bathing, washing clothes and most importantly, a source of food. Along this premise, it is the main purpose of the study to assess the water quality of Layawan River as outlined by the Department of Natural Resources (DENR) in terms of the following physicochemical parameters: phosphates, total suspended solid (TSS), pH, temperature to include total coliform to ascertain that the water from the river is safe.

II. Research Design and Methods

The descriptive normative method of research was utilized in the study with the aid of chemical, biological and physical laboratory analyses. Fresh water samples collected in the three sampling sites were analyzed at Zamboanga del Norte Quality Control Laboratory and Silliman University Marine Laboratory, Dumaguete City.

2.1 Data Collection, Sampling Procedure and Data Treatment

Temperature and pH were measured directly in the field using thermometer and pH meter respectively. Water samples for the phosphates and total suspended solids (TSS) analyses were taken by dipping 350 mL glass bottles and 1liter of plastic bottles respectively which were brought to Silliman University Marine Laboratory, Dumaguete City.

2.2 Phosphates (PO_4-P mg/L) Analysis

Fresh water samples in three replicates (350 ml each) were taken from the three sampling sites and were placed in a glass bottle properly washed with a phosphate free detergent. After which, the bottles were then soaked with muriatic acid and rinsed with distilled waterso as to ensure the purity of the samples. Samples were then placed in a styropore box with ice and were brought to Silliman University Marine Laboratory for analysis.

Stocks solutions of Sulfuric Acid, Ascorbic Acid, and Mixed Reagent were first prepared. Sulfuric acid was prepared through adding 125 ml concentrated H_2SO_4 to water and was diluted to 500 ml, stored in a plastic bottle. Ascorbic Acid on the other hand, was prepared through dissolving 5.0g ascorbic acid in an amber glass bottle with 25 ml water, and added with 25 ml sulfuric acid solution and stored in the refrigerator. Mixed Reagent was prepared through dissolving 6.25 g $(NH_4)\ 6Mo_7 0_{24}.4H_2O$ in 62.5 ml water. Then 0.25g potassium antimony tartrate (with or without $1/2H_2O$) was dissolved in 10.0 ml water. The molybdate solution was then added to 175 ml of dilute sulfuric acid with the tartrate, and was stored in a glass bottle. Then the following were added to a test tube or scintillation vial: 10 ml filtered sample, 0.2 ml ascorbic acid reagent, and 0.2 ml mixed reagent. Absorbance at 880 nm was measured between 5 and 30 minutes.

2.3Total Suspended Solids (TSS)

Three replicates of water samples were collected in each of the sampling station which placed in 1 liter plastic bottles. These were washed properly with a phosphate free soap rinsed with distilled water. The water samples were then filtered using an Improvised Filtration Apparatus and pre-weighed Whatman GFC 47 mm filters at Silliman University Marine Laboratory, Dumaguete City. The filters were pre-stabilized to constant dry weight, labeled and weighed before filtration. After filtration, each filter with residue was air-dried for 24 hours, oven dried at 100 ^{0}C to constant dry weight, and weighed again.

2.4 Sampling Procedure for Total Coliform

Bottles for the water samples were sterilized and acid washed in Zamboanga del Norte Quality Control Laboratory. They were taken from the laboratory and were tightly locked inside a box. Three sample replicates (350 mL each) were taken from each site which was right away brought back to the ZN Quality Control Laboratory, Irasan, Roxas, Zamboanga del Norte. Water samples were processed and analyzed using the Multiple-Tube Fermentation Technique for total coliform analysis. Coliform was cultured in brilliant green lactose bile broth (BGLB) tubes and were incubated at 35 ^{0}C for 48 $\pm$ 2 hours, after which gas production was recorded. The most probable number (MPN) was calculated using the 10 tube MPN table for the standard methods of examination of water and wastewater analysis.

III. Results and Discussion

3.1 Level ofthePhysico-Chemical Parameter Measurements and Total Coliform ofLayawan River

3.1.1. Phosphates

Table 1 shows the phosphate level of Layawan River. As shown, during the wet season, the phosphates content of Layawan River is 0.067 ±0.037 mg/L with Dansullan having the highest measurement. During the dry season, phosphate level was 0.08 ±0.02 mg/L with Lapayanbaja having the highest value of 0.09 ±0.03 mg/L. Generally, the dry season had higher phosphate readings as compared to the wet season.

According to [3] phosphates enter waterways from human and animal wastes (the human body releases about a pound of phosphorus per year), phosphate-rich rocks, wastes from laundries, and farm fertilizers. The higher amount of phosphates in Dansullan during the wet season could be attributed to the wastes coming from the farm animals bathing in the river as seen during the sampling time. Many of them were also seen grazed along the river. Their wastes could contribute much to the phosphates content of river systems. Similarly, many of those farm animals were seen in Lapayanbajaduring the sampling period aside from the nearby residents who were washing and taking a bath in the river.

Phosphates are compounds necessary for growth of plants and animals. It is indeed good to have them in river systems since phosphates stimulate the growth of plankton and aquatic plants which provide food for larger organisms, including: zooplankton, fish, humans, and other mammals. Plankton represents the base of the food chain. Initially, this increased productivity will cause an increase in the fish population and overall biological diversity of the system. However, if too much phosphate is present in the water, the algae and weeds will grow rapidly, hence, the phenomenon called eutrophication. When eutrophication occurs, there is a rapid growth of aquatic vegetation which will eventually dies and as it decays it uses up oxygen. This process in turn causes the death of aquatic life because of the lowering of dissolved oxygen levels. And as the phosphate loading continues and there is a build-up of phosphate in the river or surface water ecosystem, the aging process of surface water ecosystem will be accelerated. The overproduction of water body can lead to an imbalance in the nutrient and material cycling process. For the past 30 years, it has been shown that the main cause of eutrophication is the excessive nutrient inputs, usually nitrogen and phosphate. As revealed however, the result of phosphate analysis in Layawan River is at tolerable amount. It is a good indication that it is not enough to startup eutrophication.

In one way or another, phosphate does not hurt people or animals unless they are present in very high concentrations. Anyway phosphate is often scarce in the well-oxygenated lake waters and importantly, the low levels of phosphorus limit the production of freshwater systems.

Table1. The Level of Phosphates (mg/L) in Layawan River during the Wet and Dry Seasons

Study Sites	**Phosphates (mg/L)**	
	Wet Season	**Dry Season**
Dansullan	0.103 ±0.03	0.07 ±0.02
Lapayanbaja	0.05 ±0.03	0.09 ±0.03
Pian	0.05 ±0.03	0.07 ±0.01
Over All	**0.067 ±0.037**	**0.08 ±0.02**

3.1.2. Total Suspended Solids (TSS)

Table 2 summarizes the total suspended solids (TSS) in Layawan River during the wet and dry seasons. The total suspended solids (TSS) in Layawan River were 3.3E-09 ±4E-09 mg/L during the wet season with Pian having the highest amount of 4.3E-9 ±6.1E-9 mg/L and Lapayanbaja having the lowest amount of 2.1E-9 ±1.5E-9 mg/L. During the dry season however, total suspended solids (TSS) were 7.40E-09 ±5.01E-09 with Lapayanbajahaving the highest amount of 6E-9 ±1E-9 mg/L. In general, the dry season had higher TSS amount.

The total suspended solids (TSS) in surface waters occur primarily from water runoff during rainy days, stream bank and channel erosion, dead plant matter, plankton, resuspension of sediment into the water [6]. The high amount of TSS in Pian during the wet season might be attributed to the sediments brought down by the water current from the upstream due to heavy rainfall. Pian being the downstream site became the recipient of the particles brought by water current from the upstream. All the sediments, dead plant matter and other particles that could be possibly carried down by the water were down to Pian.

During dry days where rainfall is less or nothing at all, TSS amount in rivers is expected to curve down, but based on the result, TSS amount in Layawan River is higher during dry days. These could be attributed to the quarrying activities done in the area and the kind of substrate the site has. The substrate in Lapayanbaja is composed mainly of mud which would rise up when disturbed by quarrying compared to the other two sites.

According to [6],high concentration of TSS negatively affects the surface water's ecosystem and aesthetics. It can result to poor visibility which is somehow can be dangerous for swimming and diving. Indirectly, the suspended solids affect other parameters such as temperature and dissolved oxygen. Because of the greater heat absorbency of the particulate matter, the surface water becomes warmer and this tends to stabilize the stratification (layering). This, in turn, interferes with mixing, decreasing the dispersion of oxygen and nutrients to deeper layers. Based on the results of this study, TSS amount is not that high anyway. As seen during the sampling time, Layawan River is clear and the TSS analysis revealed that Layawan River contained less TSS compared to other rivers nowadays.

Similarly, [6] found less TSS in a study conducted at Layawan Headwaters in Mt. Malindang, Misamis Occidental which ranged from 3.13 to 4.66mg/L.

Table 2. TheLevel of Total Suspended Solids (mg/L) in Layawan River Duringthe Wet and Dry Seasons

Study Sites	**Total Suspended Solids (mg/L)**	
	Wet Season	**Dry Season**
Dansullan	3.7E-9 ±6.0E-9	3E-9 ±1.0E-9
Lapayanbaja	2.1E-9 ±1.5E-9	6E-9 ±1.0E-9
Pian	4.3E-9 ±6.1E-9	1.4E-8 ±2.2E-9
Over All	**3.3E-9 ±4.0E-9**	**7.4E-9 ±5.0E-9**

3.1.3. pH

Table 3 shows the pH level of the water in Layawan River during the wet and dry seasons. As seen, during the wet season, the pH level of Layawan River was 7.62 ±0.28 withPian having the highest level of 7.8 ±0.11, and Dansullan having the lowest level, 7.44 ±0.38. During the dry season however, pH level was 8.3 ±0.17 with Pian having the highest value of 8.5 ±0. Generally, there was a higher pH level during the dry season.

In a river, the water's pH is affected by its age and the chemicals discharged by communities and industries. Most rivers were basic (alkaline indicated by higher pH values) when they were first formed and become more acidic (lower pH values) with time due to the build-up of organic materials. Water's pH is critical to the survival of aquatic life. While young fish and insect larvae are sensitive to a low pH (acidic), extreme values on either end of the scale can be lethal to most organisms. Generally, mostfish can tolerate pH values of about 5.0 to 9.0, but some fishes would look for waters between pH 6.5 and 8.2. Expected level therefore is from 6.5 to 9.0. (http://www.h2ou.com/h2wtrqual.htm). The pH range of Layawan River is within the tolerable level for fishes (slightly basic). It is good for fish growth and propagation which is being supported by the presence of fish species and other aquatic organisms during the sampling period.

[6]found out that the pH level recorded in the four sampling sites of their study conducted in Layawan Headwaters, Misamis Occidental ranges from 6.8 to 7.8, which is slightly acidic. All pH readings in the sampling sites meet the DENR standards for Class AA waters.

Table 3. The pH Level of Layawan River during the Wet and Dry Seasons

Study Sites	**pH Level**	
	Wet Season	**Dry Season**
Dansullan	7.44 ±0.38	8.27 ±0.21
Lapayanbaja	7.58 ±0.16	8.27 ±0.15
Pian	7.80 ±0.11	8.50 ±0
Over All	**7.62 ±0.28**	**8.30 ±0.17**

3.1.4. Temperature

Table 4 shows the summary of the temperature reading of Layawan River during the wet and dry seasons. As revealed, the water temperature reading was 26.89 ± 0.73730^{0}C during the wet season with Dansullan having the highest reading of 27.3 ±0.23^{0}C. During the dry season however, temperature reading was 27 ±0.38^{0}C with Dansullan having the highest reading of 28 ±0.5^{0}C. In general, the dry season had higher temperature readings.

Temperature affects the quality of water systems. When it is too high, fishes will migrate because they can sense very slight temperature differences. When temperature difference would exceed to what they prefer by 1-3 ^{o}C, they move elsewhere (http://www.h2ou.com/h2wtrqual.htm). According to [7], water temperature fluctuations in rivers maybe further worsened by cutting down trees which provide shade and by absorbing more heat from sunlight due to increased water turbidity. Fishes tend to grow best at temperatures ranging from 19-32^{O}C *(*www.kywater.org/ww/ramp /rmtemp.htm).The temperature readings in Layawan River are within the tolerable ranged for fishes and other aquatic organisms. The higher water temperature during the dry season maybe attributed to the distance of the waters of Layawan River to the nearby trees which were supposed to cool down its water system. Besides, tree species found are not that much along the river bank. Though higher, it did not however exceed on the limits of the temperature that fishes can tolerate as evidenced by the presence of fishes and other aquatic organisms during the sampling period.

In Layawan Headwaters, Misamis Occidental the temperature is quite low according to the result of the study conducted by [6] compared to the present study. The mean water temperature readings vary among sampling sites, ranging from 21.2^{o}C to 22.5^{o}C. The hot spring effluent is supposed to influence the temperature reading of the river but the temperature appears not affected. The differences of the temperature readings among sampling sites could be due to the differences in the time of sampling.

Table 4. The Level of Temperature (^{0}C) in Layawan River during the Wet and Dry Seasons

Study Sites	**Temperature (^{0}C)**	
	Wet Season	**Dry Season**
Dansullan	27.3 ±0.23	28 ±0.50
Lapayanbaja	26.9 ±0.46	27 ±0.68
Pian	26.5 ±1.20	26.4 ±0.46
Over All	**26.89 ±0.70**	**27 ±0.80**

3.1.5. Total Coliform of Layawan River

Table 5 shows the total coliform in Layawan River during the wet and dry seasons. During the wet season, the total coliform was 520 ±455.74 MPN/100mL with the highest count recorded in Dansullan, 733.33 ±750.56 MPN/100 mL and the lowest count is in Pian, 346.67 ±136.14 MPN/100 mL. During the dry season, the total coliform was 890. 89 ±161.73 MPN/100mL with the highest count in Pian, 993.33 ±86.09 MPN/100 mL and lowest in Lapayanbaja, 699.33 ±101 MPN/100mL. In general, the dry season had higher total coliform. Coliform and other microorganisms thrive in places that are warm, wet, and rich in nutrient [6]. With this we could say, that the higher total coliform count during the dry season in the present study could be attributed to its higher water temperature which is good for bacteria reproduction. Besides sluggish water current could also be the other factor. Had the water been flowing faster, microorganisms would be washed away. Similarly, [6] found significantly higher coliform count in Layawan Headwaters, Misamis Occidental during the dry season which is due to the warm temperature.

Table 5. Most Probable Number (MPN) of Total Coliform per 100 mL of waterfrom Layawan River during the Wet and Dry Seasons

Sampling Sites	**Total Coliform (MPN/100 mL)**	
	Wet Season	**Dry Season**
Dansullan	733.33 ±750.56	980 ±72.11
Lapayanbaja	480.00 ±364.97	699.33 ±101.00
Pian	346.67 ±136.14	993.33 ±86.09
Over all Mean	**520 ±455.74**	**890. 89 ±161.73**

On the other hand, coliform bacteria are relatively harmless but large quantities in water would increase the risk of pathogens in the water. Most fecal coliform are normal inhabitants of the digestive tract and considered relatively harmless. In fact, their absence can lead to some types of vitamin deficiencies in humans. However, their detection in water indicates the presence of more harmful microorganisms found in feces. There were incidents reported that people become sick after drinking or swimming in water contaminated by *E. coli* 0157:H7. Symptoms of poisoning by *E. coli* 0157:H7 include bloody diarrhea, kidney damage, and occasionally death (http//www. manninen@glc.org). The present result showed however tolerable total coliform count. The river therefore is safe for the community to use as a place to bathe during wet and dry days without the fear of getting sick.

3.2 Water Quality ofLayawan River during the Wet and Dry Seasons

The water quality of Layawan River during the wet and dry seasons is summarized in Table 6. As revealed the mean for phosphates for both wet and dry seasons which were 0.0667 ±0.03742 mg/L and 0.080 ±0.02 were all within the standard of DENR for Class A water which is 0.1 mg/L.

The TSS in Layawan River ranges from 1E-10 mg/L to 1.1E-08mg/L during the wet season and 1.73E-09 to 1.51E-08 during the dry season. The computed mean (4.45E-09 ±4.449E-09 mg/L and 7.40E-09 ±5.01E-09) showed acceptable results. Both values were within the standard for Class A water which is 50mg/L.

The pH level recorded in Layawan River ranged from 7.06 to 7.94 during the wet season and 8.1 to 8.5 during the dry season. It has a mean value of 7.62 ±0.27794 and 8.34 ±0.174 which had both met the DENR standard for pH level of 6.5-8.5 for Class A water.

The water temperature readings varied from 26.3^{0}C to 27.7^{0}C during the wet season and 26.10 to 28.40 during the dry season. The difference of 1.4^{0}C during the wet season and 2.3 °C during the dry season, were both acceptable as compared to the maximum temperature rise of 3^{0}C.

Lastly the overall mean for total coliform was 520 ±455.74 MPN/100mL during the wet season and 890. 89 ±161.73 during the dry season, were all implying that Layawan River is a Class A water.

Table6. The Water Quality ofLayawan River during the Wet And Dry Seasons

Parameter	N	Wet Season			Dry Season			DENR Standard for Class A
		Min	Max	Mean	Min	Max	Mean	
Phosphates (mg/L)	9	0.02	0.13	0.067 ±0.037	0.12	0.09	0.08 ±0.02	0.1
TSS (mg/L)	9	1E-10	1.1E-08	3.3E-9 ±4.45E-9	1.73E-09	1.51E-08	7.4E-9 ±5E-9	50
pH	9	7.06	7.94	7.62 ± 0.28	8.1	8.5	8.34 ± 0.17	6.5 - 8.5
Temperature (^{0}C)	9	26.3	27.7	26.89±0.74	26.10	28.40	27 ±0.8	Maximumrise of 3°C
Total Coliform(MPN/100mL)	9	240	1600	520±455.74	598	1 040	890.89 ±161.73	1 000

The overall result shows that Layawan River is a Class A water. With this, Layawan River could be a source of water supply however, complete water treatment should be done like coagulation, sedimentation, filtration and disinfection in order to meet the National Standards for Drinking Water (NSDW). Based on DAO #34 (s. 1990), Layawan River could also be a good place for recreational activities such as bathing, swimming and skin diving as well as a suitable ground for propagation and growth of fish and other aquatic resources and

for agriculture, irrigation, and livestock watering. Similarly, the study in Layawan Headwaters, Misamis Occidental indicated a relatively healthy state of the river. The physico-chemical parameters (e.g., total suspended solids, dissolved oxygen, and nutrients) were at levels that fell within the standards set by the Department of Environment and Natural Resources (DENR) for Class AA waters [6].

3.3 Difference on the Quality of Water in LayawanRiver during the Wet and Dry Seasons

Table 7 shows the difference of the physico-chemical parameters of Layawan River during the wet and dry seasons which was analyzed using t-test at 0.05 level of significance, df of 16 and TV of 2.12. As shown, the mean for phosphates were 0.067 ±0.03742 mg/L and 0.08 ±0.02 mg/L during the wet and dry seasons with the computed t-value of 0.932278315 which is lesser than the tabular value of 2.12. This implies no significant difference in the phosphate contents of Layawan River during the wet and dry seasons. Meaning regardless of season the phosphate amount of Layawan River is within the Class A standard. On the other hand, the mean for TSS amount of Layawan River during the wet season was 3.34E-09 ±4.45E-9 mg/L and 7.40E-09 ±5.01E-09 mg/L during the dry season. The t-value obtained is 1.8172, which is lesser than the tabular value of 2.12. Hence, the computed t-value is not significant implying that regardless of season the TSS amount of Layawan River is within the Class A standard. In addition, the mean for pH were 7.62 ±0.27794 and 8.34 ±0.174 for wet and the dry seasons. The computed t-value is 6.5871 which is greater than the tabular value which is 2.12. Meaning there is a significant difference on the pH level of the waters in Layawan River. As mentioned earlier, pH was higher during the dry season which could be affected by the higher temperature and slow water current brought by dry days. Though higher, the pH level of Layawan River is still within the standard for Class A water. Lastly, the mean for temperature during the two seasons were 26.89 ±0.74 ^{0}C and 27 ±0.8 ^{0}C with the computed t-value of 0.3028 which is lesser than the tabular value of 2.12. This means acceptance of the null hypothesis. There is no significant difference in the temperature of Layawan River during the wet and dry seasons. This because there were no additional trees added or removed during the conduct of the two samplings. The waters of Layawan River were still exposed to sunlight during the sampling periods.

Table 7. Significant Difference of the Physico-chemical Parameters of Layawan River during the Wet and Dry Seasons

Parameter	Wet			Dry			Computed t	Critical Value	Decision
	Mean	SD	N	Mean	SD	N			
Phosphates (mg/L)	0.067	0.03742	9	0.080	0.02	9	0.9322	2.12	Ho Not Rejected
TSS (mg/L)	3.340E-09	4.450E-09	9	7.40E-09	5.01E-09	9	1.8172	2.12	Ho Not Rejected
pH	7.62	0.27794	9	8.34	0.174	9	6.5871	2.12	Ho Not Accepted
Temperature (^{0}C)	26.89	0.73730	9	27	0.8	9	0.3028	2.12	Ho Not Rejected

$\alpha = 0.05$ df = 16

The above results showed healthy state of the river during the wet and dry days. This implies people are safe to use the river for recreational, agricultural and livestock raising purposes regardless of season. Similarly, in the study conducted in Layawan Headwaters, Misamis Occidental indicated a relatively healthy state of the river. The physico-chemical parameters (e.g., total suspended solids, dissolved oxygen, and nutrients) were at levels that fell within the standards set by the Department of Environment and Natural Resources (DENR) for Class AA waters [6].

Table 8. The Chi-square Result of the Total Coliform (MPN/100mL) during the Wet and Dry Seasons

Sampling Sites	Seasons		Total	χ^2	Decision
	Wet	Dry			
Dansullan	2200	2940	5140	309.0044	Ho Not Accepted
Lapayanbaja	1440	2098	3538		
Pian	1040	2980	4020		
TOTAL	4680	8018	12698		
α =0.05	TV = 5.99			df=2	

Table 8 shows the chi-square result comparing the total coliform in the waters of Layawan River during the wet and dry seasons. As shown the total coliform for the wet season is 4 680 MPN/100mL and 8 018 MPN/100 mL for the dry season. As revealed, the chi-square (χ^2) value obtained is 309.0044 which is greater than the tabular value of 5.99 and found to be significant at 5% level of probability and df of 2. This means there was a significant difference in the total coliform during the wet and dry seasons. As discussed earlier, the total coliform count was higher during dry days which could bedue to higher temperature brought about by dry season. However, the result is not alarming because comparing it to the standard; the total coliform count is still within the Class A status. This implies that the presence of total coliform could not be the reason of not using the river. The community can still use the river without fear of acquiring any ailments during wet and dry days.

Nonetheless, the presence of coliform means the water could not be taken internally. If ever it would, then complete treatment should be done to destroy the possible waterborne pathogens.

Similarly, [6] found significantly higher coliform count in Layawan Headwaters, Misamis Occidental during the dry season which might be due to the warmer temperature brought by dry days also.

IV. Conclusions

The physico-chemical parameters and total coliform of Layawan River are within the standard for Class A water of Department of Environment and Natural Resources (DENR). Moreover, Layawan River could be a source of water supply however, complete water treatment should done like coagulation, sedimentation, filtration and disinfection in order to meet the National Standards for Drinking Water (NSDW). Based on DAO #34 (s. 1990) Layawan River could also be a good place forrecreational activities such as bathing, swimming and skin diving as well as a suitable ground for propagation and growth of fish and other aquatic resources and for agriculture, irrigation, and livestock watering.

References

[1]. David L. Hallock, Assessment of Changes in Water Quality in the Spokane River Between Riverside State Park and the Washington-Idaho Border,Washington State University, Department of Ecology, Olympia WA.2004.
[2]. Monica R.Lipscomb, A Critical Analysis of Indicators of Community-based Watershed Initiatives, Virginia Polytechnic Institute and State University, Falls Church, Virginia, 2003.
[3]. Brian P.Oram, What are Phosphates?. Professional Geologist/Laboratory Director, Wilkes University Center for Environmental Quality Environmental Engineering and Earth Sciences Department, Wilkes-Barre, PA 18766, 2009.
[4]. David L. Hallock, Water Quality Assessment of the Nooksack River between Brennan and North Cedarville,Washington State University, Department of Ecology, Olympia WA., 2002.
[5]. A.J. Sutton, Total Suspended Solids of Kentucky, Spingerlink Journal, 2000.
[6]. Carmelita G.Hansel, *et.al*., Assessing the Headwaters of Layawan River, Linkage Between the Terrestrial and Aquatic Ecosystems in Mt. Malindang, SEAMEO SEARCA, 2006.
[7]. J.P.Michaud, A citizen's guide to understanding and monitoring lakes and streams,Washington State Department of Ecology, Publications Office, Olympia, WA, USA., 2001.