

## **Assessment of Cagayan de Oro River: Basis for Intervention**

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### **ABSTRACT**

An assessment of the water quality of Cagayan de Oro River was conducted in Uguiaban Bridge in Sitio Balaun, Rafting Site in Barangay Mambauaya, and the New Bridge in Poblacion Area. The assessment of the river was based on water quality indicators (flow rate, pH, temperature, and total coliform), social indicators (anthropogenic activities), and level of environmental awareness. The research design used qualitative and quantitative methods to analyze the data obtained. The findings of the study showed values in water quality testing that were within standards except for total coliform that always showed exceedingly high values. In terms of the total coliform, the water quality is not within Class A standards. The highest coliform values were obtained from the Poblacion Area. However, compared to previous studies, values for total coliform have greatly reduced in all sampled areas but must require some measures to bring back the water quality to Class A. The environmental awareness survey indicated only at moderate level and has some policy implications on the residential, commercial, and industrial activities. Stringent implementation of the environmental laws is highly recommended. Extensive Information Education (IEC) campaign should also be done along with seminars on capacity building. Stringent implementation of barangay ordinances is recommended as well.

**Keywords:** Environmental awareness, water quality, sustainable intervention

## INTRODUCTION

Rivers are among the most important resources that cater to the basic needs of the growing populations. However, they also respond to changes with the passing of time and socio-economic development. Lubos (2010) has been a witness to these environmental changes through his studies that showed positive progression in the level of pollution load in Cagayan de Oro River. Zoleta (2012) had the same findings for the same river as indicated by consistently higher coliform values (27,000-566,000 MPN/100 ml) above the standard for Class A waters as stipulated in DAO 34. The higher values were detected in the downstream portion of the river. Survey results on environmental awareness from areas that are situated directly along the riverbank showed moderate awareness only.

Dowell and Wilcock (2008) provided evidence on the effects of different pastoral animals on water quality. He stressed that reduction of water quality tended to have significant effects on the ecosystem of streams, toxicity to aquatic life and loss of habitat due to sedimentation, among others. This contention was inferred from the analysis of 38 studies conducted since 1975. Another study in Australian rivers by Boulton *et al.* (2010) revealed changes on river flows. Gravel extraction, and poor management catchment have altered the extent and ecological integrity of the hyporheic zone in the area which caused the reduction of the dependent biodiversity, and this was largely attributed to sedimentation and pollution.

Since development and environment always go hand in hand, and then it would be alarming to proceed with development if the same impacts are not mitigated. Though efforts have been obviously made locally, it seems that some of these are to no avail. The same problems continue to confront the environment and its settlers. Perhaps this is a question of sustainability in terms of efforts geared because the problem may not have been properly addressed, or efforts may not have been sufficient.

The researchers intended to delve into this study as part of the tripartite environmental monitoring of one of Cagayan de Oro City's important water resources. The findings of this study will also help in designing interventions that would properly fit the situation and properly address the cause of the problem.

## FRAMEWORK

This study is anchored on the ecosystem concept that maintains an interconnectedness of its components. An ecosystem is a stable, self-regulating unit and to maintain itself, it must have a continuous input of energy (Enger and Smith, 2003). Such that, the continuous influx of energy through all components makes the system whole and functional. Any disturbance to a component then will affect the stability of the system. However, humans can take the responsibility in maintaining them. Any foreign and unnatural entity introduced into the river that is a dynamic system, can affect its stability. The contention of Schultz *et al.* (2004) supports this theory. Their study posits that the behavior of individuals developed about environmental issues is associated to the extent which the individual believes he is a part of nature. The environmental laws that are formulated by the Department of Environment and Natural Resources will limit the involvement of humans and their utilization of environmental resources.

The study is conducted to determine if the riverine ecosystem has water quality as it serves its intended uses under the Class A category.

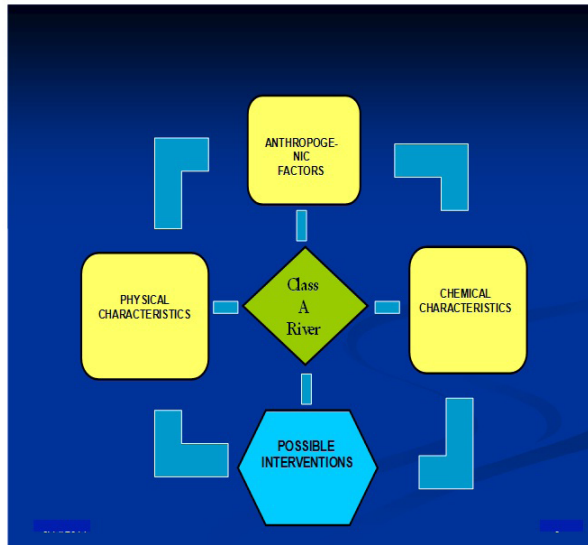


Figure 1. Conceptual Framework of the Study.

## OBJECTIVES OF THE STUDY

The study is aimed at generating baseline information of the water quality of selected areas of Cagayan de Oro River for sustainable intervention. Specifically, the study seeks to: 1) assess the water quality through water quality indicators; 2) determine the anthropogenic activities along the area; and 3) assess the level of environmental awareness of the anthropogenic factors and come up with a sustainable intervention to preserve and protect the water quality of Cagayan de Oro River.

## METHODOLOGY

### The Study Area

This study focused on the 90-kilometer Sitio Balaun-Macajalar Bay Estuary stretch consisting of two upstream and one downstream stations.

### 7.2 The Research Design

The research design employed in this study is the descriptive type. It is most suited to describe the present water quality of CDO River in terms of the parameters to be tested.

### The Research Setting

The Cagayan de Oro River originates a peak elevation of 2,865 meters above sea level ( Figure 2) and finally drains through the different tributaries into the downstream portion.

The study considered one downstream and two upstream parts of the 90-km river stretch. The upstream parts are less densely populated and covered by grassland and forest while the downstream part is inhabited by dense human settlements.

Source: Google Earth, 2012

Figure 2. Map showing the different tributaries of CDO River

## Collection of Data

### 7.3.1 Water Quality

The parameters considered in testing the water quality included pH, temperature, and total coliform. Flow rate was also assessed.

All parameters were collected in replicates employing grab sampling. The sampling procedure employed was based on standard methods provided in the WQMM as based on DAO-35.

Table 1 shows the sampling and preservation methods of the different water quality parameters.

Table 1. Sampling and Preservation Methods  
(Water Quality Parameters)

PARAMETER	CONTAINER MATERIAL	VOLUME OF SAMPLE REQUIRED (ML)	MINIMUM NUMBER OF SAMPLES/SITE	MODE OF PRESERVATION	HOLDING TIME (HRS)
Physico-chemical					
pH	*P,*G	50	3	Cool, 4°C	6
Temperature	<i>On-site determination</i>				
Flow Rate	<i>On-site determination</i>				
Microbiological					
Total Coliform	P	500	3	Cool 4°C	6

The samples were analyzed at the DOST-10 Laboratory at Carmen, Cagayan de Oro City. The bucket method was employed in obtaining the flow rate. It is considered as an easy and simple method in obtaining the flow rate (WQMM, Revised 1996).

### Survey on Environmental Awareness

Primary data on the environmental awareness was obtained using structured questionnaire. This was adapted from the studies of Miller *et al.* (2000) and Zoleta (2012).

The questionnaire was divided into three parts that yielded the following information.

#### 1. Personal information

2. Awareness of the laws based on
  - 2.1 need of the laws
  - 2.2 benefits
3. Level of awareness of environmental management
4. Identifying environmental involvement of the residents
5. Media Resources

A 4-point scale was used described respectively as very much aware, moderately aware, slightly aware, and unaware. The first description bears the highest point.

The survey process made use of random sampling from residents of 8 barangays that are situated along Cagayan de Oro River bank. A total then of eighty (80) respondents were surveyed, ten (10) from each barangay.

The results of the survey were tallied and translated into their statistical components, frequencies, and mean values.

## RESULTS AND DISCUSSION

### **Objective 1. To determine the water quality of Cagayan de Oro River in terms of its physicochemical and microbiological parameters**

Table 2 presents the summary of the status of river water characteristics from April 2015 to June 2015 as compared with DENR standards.

On the microbiological aspect, all stations had values that were way beyond the standard of 1000 MPN/100 ml regardless of the season and, therefore, exhibited non-compliance with DENR standard. The minimum value observed was 2,400 MPN/100 ml observed at the Mambuaya station in the month of April. The maximum value was 146,000 MPN/100 ml observed at Poblacion Area in the month of May. This increase that is higher than that in the month of June may be due to seasonal influence. It was raining at the time that samples were collected. The likely cause, however, for the exceedingly high values in this station in all sampling periods is the dense settlement around this area. As for the former, this may be due to its location that is at the confluence of a smaller river, the Kalawaig River, that meets Cagayan de Oro River and Mangalay Creek. These areas are above Mambuaya, that are not densely populated which may have diluted the water in the Mambuaya station. The river above and creek, according to residents in the vicinity, are being used for washing their clothes and for taking a bath.

Table 2. Summary of the status of CDO River based on DENR standards (Class A)

Parameter	DENR STD (Class A)	April	May	June
<b>Physico-chemical</b>				
Flow Rate	NA (No DENR standard value)	<b>Exhibited consistency</b> US-1.88 MS-1.41 NB-0.94	US-1.88 MS-1.61 NB-1.128	US-2.28 MS-1.806 NB-1.217
Temperature	Max rise (3°C)	<b>COMPLIED</b> US-24 MS-25 PS-27	<b>COMPLIED</b> US-25 MS-26 PS-28	<b>COMPLIED</b> US-24 MS-25 PS-27
pH	6.5-8.5	<b>COMPLIED</b> US-8.16 -8.15 -8.10 MS-8.26 -8.25 -8.27 PS-7.91 -7.89 -7.88	<b>COMPLIED</b> US-8.27 -8.29 -8.29 MS-8.32 -8.29 -8.36 PS-8.04 -8.12 -8.01	<b>COMPLIED</b> US-7.53 -7.57 -7.44 MS-7.55 -7.49 -7.46 PS-7.57 -7.56 -7.41
<b>Microbiological</b>			<b>NOT COMPLIED</b>	
Total Coliform	1000 MPN/100 ml	US1-9,200 US2-9,200 US3-3,500 <b>X-7,300</b> MS1-3,500 MS2-2,400 MS3-7,000 <b>X- 4,300</b> PS1-92,000 PS2-54,000 PS3-110,000 <b>X-85,000</b>	US1-3,500 US2-17,000 US3-11,000 <b>X-10,500</b> MS1-5,400 MS2-9,200 MS3-3,500 <b>X-6,033</b> PS1-160,000 PS2-110,000 PS3-170,000 <b>X-146,666</b>	US1-79,000 US2-26,000 US3-110,000 <b>X-71,666</b> MS1-33,000 MS2-49,000 MS3-46,000 <b>X-42,666</b> PS1-170,000 PS2-40,000 PS3-110,000 <b>X-109,000</b>

US – Uguiaban Station

MS – Mambuaya Station

PS – Poblacion Station

This conforms to the findings of McMurray and Pond (2002) and Boyer and Caccia (2005). Water quality is really “highly dependent on land use and influence from the watershed.” If the surrounding area is composed of both residential and commercial types and is densely populated, therefore the

pollution loading is expected to be high. This is true if the downstream area receives more wastewater conveyed through the outfalls located on the river banks. The additional pollution load after Mambuaya may be attributed to the additional wastewater coming from Bubunawan River, which receives wastewater from residential areas, and existing livestock and dressing plants.

While values obtained from April to June have exceeded the assimilable standard of DENR, these values now, compared to previous studies, especially by Zoleta in 2012, are much smaller with peak at 146.666 MPN/100ml. compared to previous study's peak datum of 566,667 MPN/100 ml.

**Objective 2. To determine if there is a significant difference in the water quality sampling stations in Cagayan de Oro River in terms of the physical, chemical and microbiological characteristics**

Table 3 shows the summary of the statistics on the test of difference per parameter in the month of April. Because the values are the same, these could not be statistically tested. For pH, F-computed value (229.24) is greater than F-critical value. This indicated a significant difference among stations which may be attributed to the effect of temperature in the month of May. For Total Coliform, the F-computed value (3.93) is less than the F-critical value indicating no significant difference in all stations. This finding implies that while the values are beyond the assimilable limits, the condition or degree of pollution throughout the stations is the same.

It can be gleaned from Table 4 that both pH and Total Coliform F-computed values (40.46 and 52.88 respectively) are greater than the F-Critical value indicating a significant difference among stations. For this period, the difference in pH, with the highest mean at Mambuaya station may be due to the dilution of the water with the ones coming from tributaries. As for Total Coliform, differences in values may also be attributed to the presence of tributaries at the Mambuaya confluence that caused the significant difference between Uguiaban Station and Mambuaya Station. Uguiaban Station yielded higher values due to the presence of poultry near the bridge.



Table 3. Statistics on Test of Difference by Station, Month of April

Parameter	F-Computed Value	F-Test
		At 5% Critical Value (5.14)
Flow rate	station -No Value period -	
Temperature	Station -No Value P	
pH	Station – 229.24	*
Total Coliform	Station – 3.93	**

\* - There is significant difference among stations

\*\* - There is no significant difference among stations

Table 4. Statistics on Test of Difference by Station, Month of May

Parameter	F-Computed Value	F-Test
		At 5% Critical Value
Flow rate	station - No Value	
Temperature	station - No Value	
pH	Station -40.46	*
Total Coliform	Station -52.88	*

\* - There is significant difference among stations

\*\* - There is no significant difference among stations

However, Kalawaig River and Mangalay Creek, left-side tributaries meet with Uguiaban River and dilute the water and helps in the degradation of waste. Hence, total coliform values are reduced to the next station. The same trend is in agreement with the results obtained by Zoleta (2012) in these areas but values obtained at this time were much lower.

Table 5. Statistics on the Test of Difference by Station, Month of June

Parameter	F-Computed Value	F-Test
		At 5% Critical Value
Flow rate	station - <b>No Value</b>	<b>No Value</b>
Temperature	Station - <b>No Value</b>	
pH	Station - 0.04	**
Total Coliform	Station - 0.48	**

\* - *There is significant difference among stations*

\*\* - *There is no significant difference among stations*

Table 5 shows the summary of the statistics on the test of difference per parameter in the month of April. The F-computed values were less than the F-critical values thus indicating no significant difference among the stations. This implies that while the values obtained were higher than the DENR assimilable values, the degree of pollution of the said stations in this period is the same. This result may be due to seasonal influence signaled by the cloudy conditions at the time of sampling that brought rain showers in all areas. However, the values obtained, while these are still beyond standard values, are much lower at this time compared to the consistently higher values obtained by Zoleta (2012).

Table 6. Statistics on Test of Difference by Parameter and by Period

Parameter	F-Computed Value	F-Test
		At 5% Critical Value
Flow rate	No Value	
Temperature	No Value	
pH	Period- 268.65	**
Uguiaban	Period- 550.26	**
Mambuaya	Period- 60.82	**
Poblacion		
Total Coliform		
Uguiaban	Period- 2.01	*
Mambuaya	Period- 48.83	**
Poblacion	Period- 2.26	*

\* - There is significant difference among stations

\*\* - There is no significant difference among stations

Table 6 shows the result on the test of difference for pH and Total Coliform in all periods. Uguiaban station yielded a higher computed value (268.65) for all periods indicating a significant difference. The month of June had lower values (near neutrality) which may have been influenced by the start of the rainy season. The same condition applies to the other stations (Mambuaya -550.26 and Poblacion -60.82).

Except for Mambuaya, in terms of pH (by period) both Uguiaban and Poblacion Stations did not exhibit any significant difference in all periods. Hence, their conditions were the same. Mambuaya station yielded an F-computed value of 48.83 which indicated a significant difference in Total Coliform among stations within the three-month period. The month of June yielded values (22,666 MPN/100 ml) for Total Coliform that are significantly higher than in April and May with 4,300 MPN/100/ml and 6,300 MPN/100 ml respectively. The higher coliform value in the month of June may be caused by seasonal influence.

Then, all stations sampled are polluted, however, the extent of pollution compared to the study of Zoleta (2012) has reduced as well in all areas.

### Objective 3. To find out the anthropogenic activities along CDO River

Table 7 and 8 show the business establishments in the upstream and downstream parts respectively, of CDO River. The nature of its product categories may influence the condition of the river system. These establishments

operate with discharge permit and, under Environmental Compliance Certificate (ECC) conditions and therefore, are covered by the periodic monitoring process of the Environmental Management Bureau (EMB-10). Under the discharge conditions, they have to maintain a minimal waste flow discharge of 3,240 cc/year and under the ECC conditions they have to put up a waste treatment facility. However, the following violations per DENR records were seen from among the listed industries: no permit to operate, alleged black smoke emission of Asphalt Batching in 2001, exceedance in BOD in 2001 non-compliance with required waste treatment facility in 1996, and washing of trays in the river.

Table 7. Business Establishments in the Upstream Part of CDO River

Trade Name	Address	Product Category
Vista de Rio Farm	Sitio Maasin, Nicdao, Baungon Bukidnon	Livestock
YSD Agri-Ventures Corporation	Kibawe, Libona, Bukidnon	Broiler
Nicdao, Baungon, Bukidnon	Nicdao, Baungon, Bukidnon	Cassava Starch
Phil-Agro Industrial Corporation	Sitio Maasin, Baungon, Bukidnon	Cassava Starch
Five Jewels Piggery Farm	Sitio Maasin, Nicdao, Baungon, Bukidnon	Swine Breeding Fattening
VDR Farm	Sitio Maasin, Nicdao, Baungon, Bukidnon	Dressing Plant
Zoos (Menzi)	Talakag, Bukidnon	Paper Recycling

Source: DENR-EMB

Table 8. Mineral Production Establishments in the Downstream Part CDO River, 2013

Location	Mineral Production	Area (in has.)	Volume (cu. m/mt)
<b>Balulang</b>	Sand and Gravel	1	-
<b>Consolacion</b>	Sand and Gravel	2	4,950
<b>Kauswagan</b>	Sand and Gravel	0.95	450
<b>Macasandig</b>	Sand and Gravel	1	1,100

**Objective 4. To determine the level of environmental awareness of the barangay residents along CDO river**

Table 9 shows the frequencies and mean values for awareness questions. The mean values were compared to the range of values adapted from G. Tyler Jr. (2000) with the range 3.26-4.00 as very much aware, 2.51-3.25 as moderately aware, 1.76 – 2.50 as slightly aware, and 1.00 – 1.75 as unaware. As shown in the environmental awareness questions, the highest mean (2.91) falls on item 1.5 “I am aware that barangay undertakings regarding environmental management will bring more benefits to the community” verbally described as moderately aware, respectively. On the other hand, the lowest mean (2.70) fall on item on “1.1 I am aware of the existing environmental laws” and in item 1.2 “I am aware that environmental laws are for the protection of the environment as well as water bodies” verbally described as moderately aware.

Table 9. Frequencies and Mean Values for Awareness Questions

<i>Questions</i>	<i>F1</i>	<i>F2</i>	<i>F3</i>	<i>F4</i>	<i>Total</i>	<i>X (mean)</i>	<i>Descriptive Measures</i>
	4	3	2	1			
<b>Environmental Awareness</b>							
1. Existing laws and policies							
1.1 I am aware of existing laws	32	33	12	3	80	3.17	Moderately Aware
1.2 I am aware that environmental laws are for the protection of the environment	41	18	12	5	80	3.29	Very Much Aware
1.3 I am aware that environmental laws are implemented in our barangay	31	30	11	8	80	3.05	Moderately Aware
1.4 I am aware of projects carried out to intensively implement environmental laws	30	23	20	7	80	2.94	Moderately Aware
1.5 I am aware that barangay undertakings regarding environmental management will bring benefits to the community	45	22	11	2	80	3.38	Very Much Aware
Overall						3.20	Moderately Aware
<b>On Waste Management</b>							
2.1 I am aware that household wastes should be segregated at source	55	19	3	3	80	3.58	Very Much Aware

<b>Questions</b>	<b>F1</b>	<b>F2</b>	<b>F3</b>	<b>F4</b>	<b>Total</b>	<b>X (mean)</b>	<b>Descriptive Measures</b>
	<b>4</b>	<b>3</b>	<b>2</b>	<b>1</b>			
2.2 I am aware that segregation at source can be done through recycling and reuse	46	26	6	2	80	3.46	Very Much Aware
2.3 I am aware that waste thrown anywhere can cause clogging of canals leading to street clogging	60	13	5	2	80	3.64	Very Much Aware
2.4 I am aware that open burning is prohibited by law	49	21	8	2	80	3.42	Very Much Aware
2.5 I am aware that direct throwing of garbage to the river can cause pollution	69	5	2	4	80	3.77	Very Much Aware
Overall						3.57	Very Much Aware

## CONCLUSIONS

From the findings of this study, the following conclusions are drawn:

First, except for Total Coliform, the water quality of Cagayan de Oro River is in compliance with standard values. However water quality in terms of the microbiological characteristic is impaired.

Second, there is a significant difference in the water quality of the river between stations in terms pH and total coliform that are habitat- and season-influenced.

Third, the water quality of Cagayan de Oro River falls under Class A except for total coliform that went way beyond the minimum standards. Thus, it may be said that the Cagayan de Oro River stretch is organically polluted. The Pollution loading in terms of total coliform is higher than the standard values stipulated in DAO-34 and must require some measures to bring it back to Class A level.

Fourth, it is the downstream part of Cagayan River particularly the Poblacion areas that are greatly impacted by land-based pollution in terms of total coliform.

Finally, the potential sources of organic pollution are the residential, commercial, and industrial areas.

## RECOMMENDATIONS

### Policy Implication

The results of the study revealed a moderate level of environmental awareness among barangay residents hence more efforts should be geared toward intensifying this through more extensive Education Campaign, symposia, and seminars. The academe can contribute largely by strengthening and intensifying its community involvement through community extension. As a research-based educational institution, Liceo de Cagayan University should seek more ways to utilize the study results by continuing to conduct IECs and capacity-building seminars to educate the residents more and increase their level of environmental awareness. Moreover, a more stringent implementation of existing barangay ordinances on solid waste management should be enforced.

### Management Implication

The Local Government Units should continue to monitor identified potential causes of pollution livestock and dressing plants in the upstream areas and come up with sustainable solid waste management practices. Storm drain clean-ups should be encouraged on a periodic basis at the barangay level.

### Research Implication

It is recommended that future researchers should establish more sampling sites with additional water quality parameters like dissolved oxygen, biological oxygen demand, nitrates and pesticides for more comprehensive results.

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