



Impacts of management programs to biophysical resources of Cagayan de Oro River, Northern Mindanao, Philippines

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Abstract. The study was undertaken to determine the status of recent management programs implemented and initiated by various multi-sectoral organizations from the Local Government, NGAs, Academe, and National Agencies towards the Cagayan de Oro River resources and to its immediate community. Secondary data obtained on water quality revealed that domestic, socio-economic and cultural factors did not significantly influence on the water quality of the river, but that population growth magnifies the impact, it is also supported that *Escherichia coli* from domestic wastes is highest at downstream which is densely populated compared to upstream. Validation survey suggests that people are knowledgeable that river discharges runoff from upstream activities, and agrees that there are existing organizations and government agencies in the barangay that implement environmental programs. The river still hosts a lot of organisms, but the respondents would attest that the past conditions of the river and its resources are better compared to the present. Majority of the respondents agree that Cagayan de Oro River is already polluted. However, they have expressed intent to participate in management and conservation programs for the betterment of its resources. The benefits derived from the river are critical to the functioning of the life support system of the communities by which people are willing to pay minimum monetary value for its sustainability. Further it is recommended that management efforts must be narrowed down to the community level in order to elicit participation and because they are most knowledgeable on the status of the existing river resources. Thus, there is a need for scientific inputs for resource-based studies in order to update data and provide reliable baseline for the application of appropriate management programs, and considering reforestation efforts to also focused on riparian zones, with appropriate financial allocation and lastly, the need for inter-council agreements should be enhanced and clarified to address geographical contexts and jurisdiction on the implementation of programs.

Key Words: environmental management, initiatives, knowledge, perception, attitude, multi-sectoral.

Introduction. Rivers provide critical supply of freshwater for many human societies and ecosystems (Gleason & Smith 2014) on which humans derive utility benefits from the environmental services of biological communities it hosts (Myers 1996). The rivers and riparian zones have both aquatic and terrestrial communities which interact on well-functioning food webs fundamental for sustaining life (Naimen et al 2012). In the local setting, Cagayan de Oro River was identified as one of the highly polluted river systems in Northern Mindanao; the siltation, domestic wastes and runoffs of this river were attributed to various urban and upstream practices (DENR 10 1996).

Managing riparian zones and river ecosystems is based on numerous and complex factors (Skally & Sagor 2001). Institutions working together are most successful in managing resources; take as an example the Coordinated Resource Management in the Feather River Watershed in California (London & Kusel 1996). Recently there have been various management interventions being implemented within the Cagayan de Oro River basin, by which it is also being overseen by organizations such as the Cagayan de Oro River Basin Management Council. In this study, these local initiatives from the

Government, non-Government, and Multisector Agency programs will be assessed to understand the current status and fate of the river, along with the current status of selected biophysical parameters obtained from recent studies conducted on the river resources. The residents in the area will also be interviewed to determine their knowledge and perceptions about the river and its uses, and their attitude towards the management and conservation of the river resources. The result of this study will be used as future reference in terms of river resource management and even inputs to the formulation of management policies by the CDORBM Council and alike, that will mitigate environmental degradation of river ecosystems.

Material and Method. The study commenced during the month of June 2016. Three sampling stations for the socio economic survey shall be established on the riparian communities covering three Barangays which is geographically attributed to the River System (Figure 1); Station 1 Kauswagan (downstream) and Station 2 Carmen situated midstream and directly adjacent to the river outflow areas, and Station 3 Lumbia which is situated upstream.

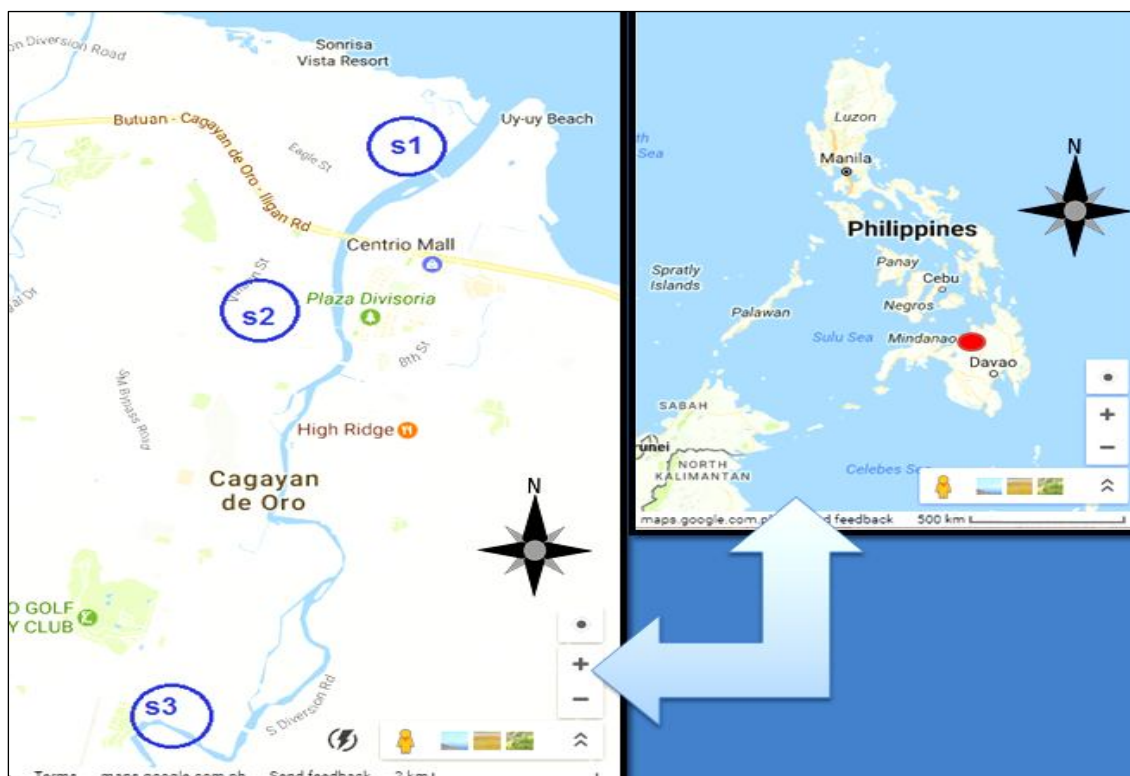


Figure 1. Location of the sampling stations in Cagayan de Oro River, Cagayan de Oro City, Northern Mindanao, Philippines.

Demographic profile was gathered to indicate the communities' general belongingness in terms of gender, age, civil status, highest educational attainment, source of income and type of housing. Total sample size (s) from the number of respondents (N) was determined using Sample Size Determination Table (Krecjie & Morgan 1970).

Validation survey of peoples knowledge, perception, attitude and cost valuation (willingness to pay) was obtained using structured questionnaires translated to local dialect which is cebuano.

Recent studies about biophysical resources of Cagayan de Oro River (i.e. organisms, water quality) were referred to secondary data (obtained from Raagas & Villuaneva 2014; Lubos & Japos 2010) were referred to secondary data that determine present conditions of selected biophysical parameters and resources of the river.

Primary data was analyzed using descriptive statistics through percentages and means and illustrated using two-dimensional graphs and tables.

Results and Discussion

Biophysical resources. The Cagayan de Oro River Watershed covers an approximate of 137,933.77 hectares is provided by eight tributaries namely Bubunawan-Cagayan Rivers by which 23% (32,117 ha) is landslide prone of the total area, while erosion prone areas covers 32% (44,287 ha) of the total areas. A study conducted by Raagas & Villanueva (2014) revealed that domestic, socio-economic and cultural factors did not significantly influence on the water quality of the river (Table 1), but that population growth magnifies the impact of these factors.

Table 1
Water quality values on selected water stations in Cagayan de Oro River
(Raagas & Villanueva 2014)

Water parameter	Station 1 Balulang Cagayan de Oro City	Station 2 Nicdao Cagayan de Oro City	Station 3 Balaon Talakag Bukidnon	DENR DAO 1990- 34 Std. Waste Water Values
BOD (mg L ⁻¹)	2.67	2.75	3.0	5.0
Chloride (mg L ⁻¹)	5.33	2.99	1.83	250.0
Color (PCU)	70.49	73.36	117.24	50.0
DO (mg L ⁻¹)	8.79	8.85	8.89	70.0
pH	7.55	7.26	7.14	6.5-8.5
TDS (mg L ⁻¹)	119.17	116.17	86.83	50.0
Temperature (°C)	25.17	24.51	23.48	3.0
TSS (mg L ⁻¹)	57.17	102.84	95.91	50.0

BOD - biological oxygen demand; DO - dissolved oxygen; TDS - total dissolved solids; TSS - total suspended solids.

In a similar study in Indonesian Ciliwung, Sunter and Krukut Rivers, it is suggested that the overall water quality was poor and very poor (caused due to heavy metals that did not exceed their current water quality standards). This is a similar case that the rivers are also their sources of raw water materials for municipal supply and is a recipient of wastes from inhabitants and industries (Palupi et al 1995).

The average total fecal coliform values obtained have exceeded the acceptable value set by the DENR (1990). This indicates that fecal contamination of the river water quality is above the guidelines at 1000 fecal coliform organisms/100 mL. Whereas downstream areas (i.e., Brgy Bonbon) has the highest level of fecal contamination and upstream (i.e., Dansolihon, Table 2) has the lowest (Lubos & Japos 2010).

Table 2
Coliform load values (Most probable number method/MPN) among upstream, midstream
and downstream stations at Cagayan de Oro River (Lubos & Japos 2010)

Sampling area	Total coliform count (MPN/100 mL)	Fecal coliform count (MPN/100 mL)	Escherichia coli (MPN/100 mL)
UPSTREAM			
1. Mambuaya	3500	5990	3420
2. Dansolihon	11833	2496	1296
3. Bayanga	8300	6933	3980
MIDSTREAM			
4. Lumbia	4400	3400	3230
5. Upper Balulang	9566	7270	5629
6. Nazareth	13733	4976	2056
DOWNSTREAM			
7. Isla de Oro	13733	6866	1730
8. Kauswagan	13733	6933	6933
9. Bonbon	>16000	8300	7066

Water pollution due to change of organic natural composition and accumulation of microorganisms can cause death and diseases, and reduce availability and survival of aquatic organisms. It can also reduce the reproduction reproductive ability of of aquatic organisms due to the occurrence of diseases (Enger & Smith 2000).

Management programs. The Cagayan de Oro River Basin Management Council (CDORBMC) serves as the governing body for the operation supervision and management programs. The council was organized for the rehabilitation, protection, and management of the river basin's resources. The Urgency for the formation of CDORBMC was realized because of the Cagayan de Oro river basin's timely vulnerability to climate change and multi-hazard risks.

From the Academe the "Safer River Life Saver Foundation, Inc." of Liceo de Cagayan University (LDCU) aimed to protect and enhance the ecology of the Cagayan de Oro River. SRLSFI is a community service in extension and research to maximize benefits that is derived from the river's vast potential resources for the best interest of society, its programs include local capacity building related to health and sanitation, education, livelihood development, and skills development. They also work with indigenous people. The environmental programs include: solid waste orientation, clean-up drive, tree planting/tree growing, river patrol/monitoring, coastal resource management and eco-tourism.

National initiatives such as the River Basin Control Office (RBCO) DENR 10 accounts to Cagayan de Oro River Basin and has close ties with River Basin Organization (RBO) such as the Cagayan de Oro River Basin Management Council (CDORBMC) in implementing management programs. The RBO is responsible for the crafting of River Management Master Plans that will be endorsed by the River Development Council and RBCO for National budget appropriations of the DENR. The agency has also designated the river basin as a "water quality management area" or WQMA (DENR Administrative Order No. 2013-18). Other programs includes funding from foreign agencies such as Japan International Cooperation Agency (JICA) partnered with Department of Public Works and Highways (DPWH) to develop infrastructural flood control projects

Socio-economic profile. The survey for validation covered a total of 250 respondents living directly in the riparian communities. Among the three stations almost all respondents are evenly distributed according to gender (52 percent male and 48 percent female, Station 1). There were more female respondents in Station 2, with 60 percent female, compared to 40 percent male. Station 3 however comprise of 47 percent male and 53 percent of female respondents (Figure 2). Majority of the respondents belong to the middle aged group (36-45 years old) with 36 percent of the population (Figure 3). Most of the respondents surveyed are generally young, followed by those at 26-35 years old and 18 to 25 years old with 22 and 18 percent, respectively. In terms of civil status, most of the respondents were married, comprising to more than 60 percent of the population (Figure 4). Educational attainment of the respondents mostly belonged to tertiary level, with 50 percent of the respondents (Figure 5). These could be attributed to the fact that the sampling stations are located near schools and provides greater opportunities for higher educational attainment. Results showing distribution of respondents according to sources of income suggests that majority of the respondents within the sampling areas are self-sustaining with 37 percent having medium to large size business enterprise. Thirty (30) percent of the respondents are employed in private institutions while 28 percent are unemployed (Figure 6). Those employed with the government are only a minimum of 5 percent among the total respondents. Majority of respondents have concrete type houses (58%) while the rest, comprising 42 percent, have wooden houses (Figure 7).

It is important that people, especially those in the communities, acquire appropriate knowledge and awareness about the concepts and status of natural resources in the environment (Palmer 1998) so that critical judgment can be achieved. When asked whether Cagayan de Oro River discharges runoff from upstream activities, majority of the respondents, with 55.25 percent, agreed (Table 3). It is evident that after occurrence of

rain the river is visibly filled with runoff being discharged downstream to the estuary and coastal areas. The respondents also agree that there are existing organizations and government agencies in the barangay that implements environmental program concerning the status of the river (67.58%). The community respondents within the riparian area agree that the river still hosts a lot of organisms such as fishes (61.47%) but would attest that the past conditions of the river and its resources are better compared to the present (55.25%). The respondents agree that the river resources are important to humans (59.17%).

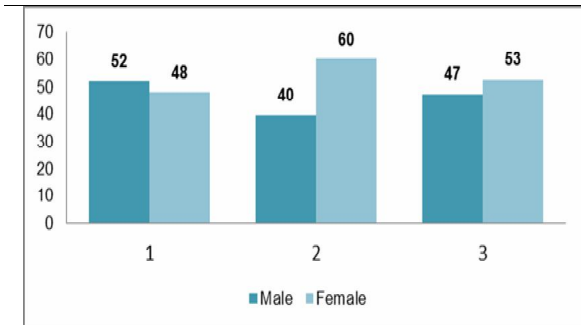


Figure 2. Percent distribution of respondents according to gender among the three sampling stations.

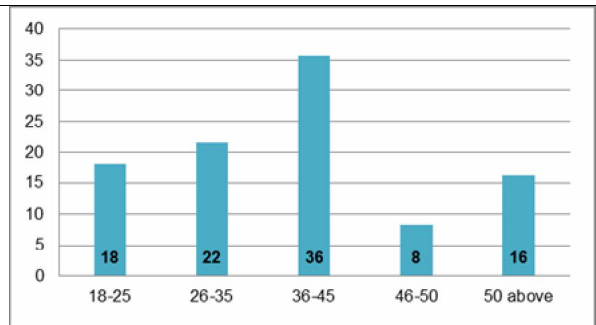


Figure 3. Percent distribution of respondents according to age.

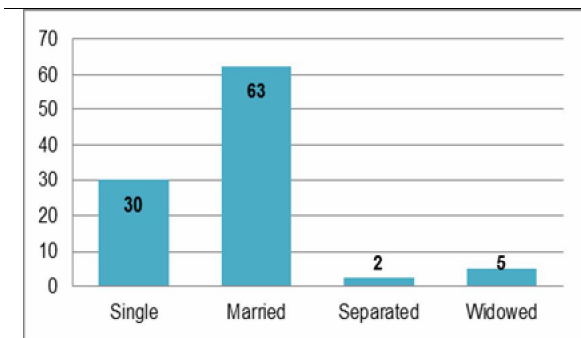


Figure 4. Percent distribution of respondents according to civil status.

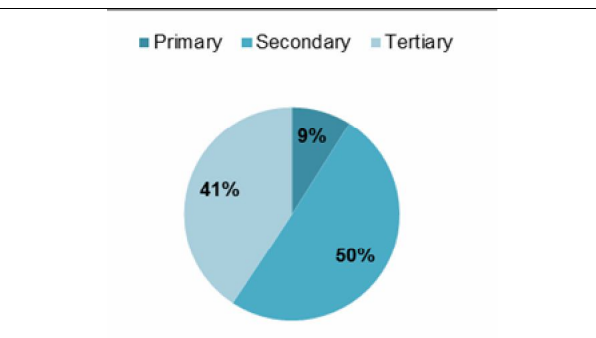


Figure 5. Percent distribution of respondents according to highest educational attainment.

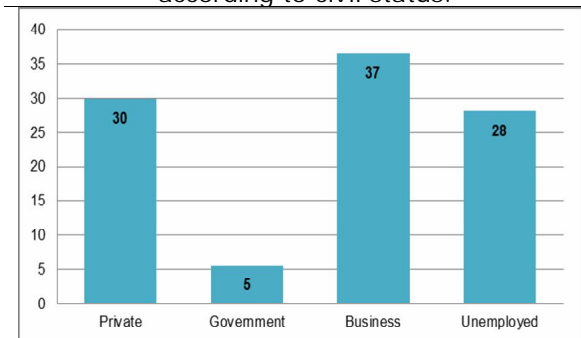


Figure 6. Percent distribution of respondents according to source of income/livelihood.

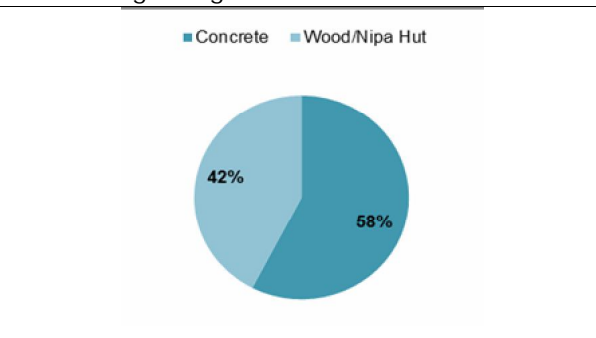


Figure 7. Percent distribution of respondents according to type of housing.

Table 3

Respondents knowledge on the river resources

	SA (%)	A (%)	D (%)	SD (%)
1. Cagayan de Oro River discharges runoff from various activities upstream including the estuary and coastal areas	38.81	55.25	4.57	1.37
2. There are organizations and government agencies in the barangay with environmental program concerning the status of the river	24.20	67.58	7.76	0.46
3. River organisms such as fish and others are still plenty in the river?	24.77	61.47	10.09	3.67
4. The condition of the River and its resources are much better in the past years than today	36.53	55.25	3.65	4.57
5. The river resources are important to humans	37.61	59.17	1.83	1.38

SA - strongly agree; A - agree; D - disagree; SD - strongly disagree.

The people that live within the riparian zone and those locate their activities, such as fishing adjacent to river environments are some of the reasons why rivers and the natural habitats have been destroyed or altered. Rivers ecosystems have been used extensively as dumping grounds for domestic and industrial wastes generated by the activities associated with human settlements and coastal developments (National Academy of Sciences 1995).

The survey also assessed the respondents' perception regarding the status of the river and what activities have contributed to these changes. Fifty four (54%) percent out of two hundred fifty (250) respondents agree that Cagayan de Oro River is already polluted and 38 percent more have indicated that they strongly agree. Majority of the respondents, constituting 56.74 percent, agree that pollution is contributed by mining and deforestation activities going on upstream while 32.56 percent of respondents also strongly agree. This majority also agree (63.55%) that pollution in the rivers affects the riparian community, including the abundance of organisms that thrive in the river and coastal areas (67.61%, as shown in Table 4).

Table 4

Respondents perception on the activities that contribute to the status of river

	SA (%)	A (%)	D (%)	SD (%)
1. Cagayan de Oro River is already polluted	38.43	54.63	5.55	1.39
2. Mining and deforestation is the major contributor of sedimentation in the rivers	32.56	56.74	9.30	1.40
3. Pollution in Cagayan de Oro River greatly affects the nearby and riparian communities	32.71	63.55	3.27	0.47
4. Pollution in the river affects the abundance of organisms in the river and coastal areas	29.10	67.61	2.82	0.47
5. The people are knowledgeable about the activities and different organizations working in their barangay which concerns the welfare of the river	22.54	53.05	22.54	1.87
6. Destruction of the river ecosystem is a government concern	22.90	40.19	23.36	13.55

SA - strongly agree; A - agree; D - disagree; SD - strongly disagree.

Rivers habitats like marsh and mangrove forests act as filters for pollutants and excess sediments and nutrients out of the water. For this reason, rivers, while being some of the most fertile ecosystems, are also some of the most polluted (Salcomby – Kingsbridge Estuary Conservation Forum 2002). In the Philippines, the deposition of sand and silt at bottom of bays and rivers have shallowed most river systems and destroyed the natural grounds of freshwater fishes (NEPC 1983; MSU Naawan FSTDI 1995). This case is also true for Cagayan de Oro River.

Finally, respondents were assessed to determine their level of attitude towards conservation of Cagayan de Oro River based on their knowledge and perception on the rivers resources. Majority of the respondents (57.48%, shown in Table 5) agree that mining and deforestation activities upstream should be prohibited, if not, regulated. Fifty (50%) percent agree that the river ecosystem, along with its ecological services, must be protected. In addition, some 48 percent of the respondents strongly agree to the idea. Respondents, about 52.80% of them agree and 45.33% strongly agree that there is a need for an educational enhancement program that focuses on the importance of river resources for the people of the community. People should also participate and play a significant role in the management programs being implemented by the local government unit (LGU) and other active organizations for the betterment of the river and the protection of its resources.

Table 5

Respondents attitude towards the status of the river

	SA (%)	A (%)	D (%)	SD (%)
1. Mining and deforestation should be prohibited upstream	38.79	57.47	3.27	0.47
2. The river ecosystem must be protected	48.36	50.70	0.00	0.94
3. The people should be taught about the importance of river resources in a community	45.33	52.80	1.40	0.47
4. People should participate in management and conservation programs of LGU and other respective organizations for the betterment of the River and its resources	42.99	55.61	0.47	0.93

SA - strongly agree; A - agree; D - disagree; SD - strongly disagree.

The benefits derived from the river as an ecological system and the benefits from its natural resources are critical to the functioning of the life support system of the communities. Cagayan de Oro River contributes to the community, both directly and indirectly, and therefore represents an economic value. The survey assessed the respondent's willingness to pay the corresponding price-range-value estimates which were given (Figure 8).

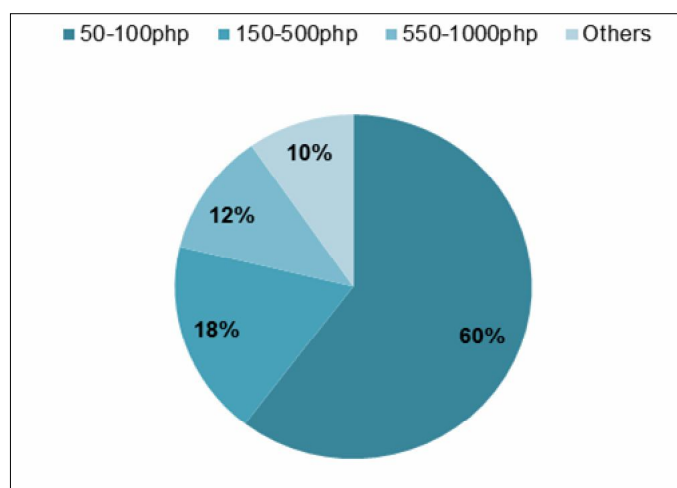


Figure 8. Percent distribution of annual willingness to pay for the conservation of Cagayan de Oro River.

Results indicate that majority of the respondents, with 60.39 percent, are willing to pay the minimum price range value of 50.00php to 100.00php on an annual basis. The key concern among environmental economists is that the annual value of the environment is estimated to be about twice that of annual income. In other words, the value of the environment is priceless (Whitehead 2006).

Conclusions and recommendations. Management programs being implemented in the Cagayan de Oro River Basin by multi sectoral agencies, is important to ensure sustainability of biophysical resources and to understand the level of knowledge, perception, and attitude of people towards valuing river resources situated in the riparian communities. Thus, this study integrates baseline data from management programs, biophysical resources and socio-economic variables in formulating an enhanced environmental management scheme.

Results of the Knowledge, Perception, and Attitude (KPA) survey suggest the need for ecological literacy among community members, particularly for those in the riparian communities. The knowledge to be obtained by the people is necessary to comprehend the interrelatedness and interdependence occurring in the ecosystem that would elicit an attitude of stewardship of the rivers' resources. Because there is high awareness, this awareness should be a driving force to stimulate action to improve the status of the river. And by acknowledging that there is an environmental problem existing, reforms should entail that communities and stakeholders must be more cognizant about the state of environment. Degree of environmental awareness involves a personal commitment to work to solve environmental problems. It also proposes a viable approach for integrated water management that would involve the creation of a framework of alternative river basin management scenarios that can combine inputs from the various scientific disciplines.

Cagayan de Oro River Basin does not lack the necessary programs, management interventions, and support needed to establish sustainable practices for the rivers natural resources. Local, regional, and national initiatives has already been set to fully operate in addressing resource base, socio-economic, and disaster issues concerning the river basin. Although there are areas needed for improvement particularly on the recent status of the river's biophysical resources (i.e. water quality and organism). There are still a lot of improvements to be done on the programs especially those that are resource based. Additional scientific inputs must be established by encouraging the academe and even the scientific community whether local or national to further studies within the river's biophysical resources, this is to update data and provide reliable baseline for the application of appropriate management program. Further, reforestation and forest rehabilitation must not only focused on watershed and upstream areas but also on the riparian zones itself, such as areas near the riverbanks to that would serve as natural erosion controls.

The resource based approach on management would also require appropriate funding support that may be coming from concerned group such as NGAs, NGOs, sectoral organization and must especially from the local and national government, to be considered as a priority program addressing very crucial ecosystems in the country. Proper accountability and monitoring should also be observed for the funding of these programs.

Much can be done through multi-sectoral cooperation from the academe, government agencies, non-government agencies, private/sectoral group, and most importantly the local communities which should be primary drivers in developing change. Validation implies that there is high level of awareness in terms of the people knowledge, perception and attitude towards the rivers status and resources. And there is a clear regard for people valuing the sustainability of the river, given that these community members are dependent on both direct and indirect benefits provided by the river ecosystem.

The people express its intent to participate in the involvement on local programs implemented by the LGU for the sustainability of CDO River; this implies that the LGU and perhaps other agencies should maximize this opportunity on the people's involvement and also implement the initiatives up to the community level. Whereas, local community members are empowered and enhanced to do the leg work in promoting environmental awareness and regulate resource use.

Although such partnerships are already established, the need for inter-council agreements should be enhanced and clarified to address geographical contexts and jurisdiction of the implementation of programs, whereas, local council and organizations

could work together and have proper delineation on management areas especially that rivers are encompassing and connects different provinces and regions (i.e., watershed of Cagayan de Oro River may cover two or more provinces).

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