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# Riparian zone analysis using Riparian, Channel and Environmental (RCE) inventory and water testing analysis in Lun Padidu river, Lun Padidu, Malapatan, Sarangani Province, Philippines

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**Abstract**. The Riparian Channel and Environmental (RCE) inventory was developed to quickly assess the physical and biological conditions of small streams in lowland, agricultural landscapes in temperate regions that have been physically modified. Furthermore, the inventory was developed to assess physical disruption of the channel and riparian zone. There were three sites used to conduct the study which measure 2 kms and 4 kms upland and 2 kms downland from the origin point which is the bridge. Water samples were taken from each site. Physico-chemical testings were used to assess the sample. Results revealed that the Lun Padidu river is under the classification of very good status for the RCE and the data results of the water samples showed that the water is suitable for the convenience of living.
**Key Words**: riparian zone, physico-chemical parameters, riparian channel and environmental inventory.

**Introduction**. The Philippines is surrounded by bodies of water: seas and oceans. Along the 7,100 islands, there are streams, lakes, swamps and rivers and other bodies of water which are the source of sustainable water for irrigation and fish culturing industries. These bodies of water support the diverse wildlife species and humanity. Furthermore, they help to maintain the ecological balance in a community specifically in agricultural lands. Since Philippines is an agricultural country, one of its primary concerns is to maintain the preservation of rivers which is the primary source of water. The importance of knowing the status of the water and the riverbanks will help to establish proper practices to avoid pollutions to maintain the stability of the river.

Physico-chemical parameters work together with the biological indicators in determining water quality. These parameters are dissolved oxygen (DO), power of hydrogen (pH), temperature (T), total dissolved solids (TDS) and salinity. The dissolved oxygen parameter is one of the most important indicators of the quality of water foraquatic life. It is essential for all plants and animals. Oxygen availability throughout the year is influenced by other chemicals present in the water, biological processes, and temperature. A dissolved oxygen test measures the amount of oxygen dissolved in the water. A dissolved oxygen measurement, however, does not measure the amount of disolved oxygen the water is capable of holding at the temperature at which it was tested. Warmer water is capable of holding less dissolved oxygen than colder water. When water holds the entire DO it can hold at a given temperature, it is said to be 100 percent saturated with oxygen. If water holds half as much oxygen as it can hold at a given temperature, it is 50 percent saturated (http://www.longwood.edu).Temperature is affected by air temperature, stormwater runoff, groundwater inflows, turbidity, and exposure to sunlight. In considering the health of organisms, it is necessary to consider

their maximum temperature and optimum temperature. The maximum temperature is the highest water temperature at which the organism will live for a few hours. The optimum temperature is the temperature at which it will thrive (http://fosc.org). Changes in water temperature regimes impact all aspects of physiology, behavior, and life history strategies of aquatic organisms (Naiman & Anderson 1997). Total dissolved solids is dependent on the type of solids dissolved in water, and can be changed depending on the water source (http://www.fondriest.com). Salinity is the amount (in grams) of dissolved solid material in a kilogram of seawater after all the bromine has been replaced by an equivalent quantity of chlorine, all the carbonate converted to oxide, and all of the organic matter destroyed (http://www.aslo.org). pH is a measure of a solution's acidity. In water, small numbers of water molecules ($H_2O$) will break apart or disassociate into hydrogen ions ($H^+$) and hydroxide ions ($OH^-$). Other compounds entering the water may react with these, leaving an imbalance in the numbers of hydrogen and hydroxide ions. When more hydrogen ions react, more hydroxide ions are left in solution and the water is basic; when more hydroxide ions react, more hydrogen ions are left and the water is acidic. pH is a measure of the number of hydrogen ions and thus a measure of acidity (http://fosc.org). The results would imply that the activities along the rivers contribute to its nutrient concentration (Guldin 1989). The importance of these parameters is that they served as the indicators of the present condition of the water in the river.

The Riparian Channel and Environmental (RCE) inventory is an analysis which uses different factors to consider the current condition of a specific riparian zone from large riverbanks to small streams. The term “riparian” comes from the Latin word “riparius”, meaning “bank of stream” (Dunne & McGinnis 2002). Riparian zones provide a variety of functions, including the prevention of excessive stream bank erosion (Hassan et al 2005). Riparian areas are simply defined as the green areas found along the edges of rivers, streams, lakes, ponds and wetlands. Riparian area or zone can be defined also as an ecological complex, which is directly adjacent to a water body including flood plains and wetlands (Parson 1991; Walker 1993) and can also include intermittent streams which sometimes run with water (Askey-Doran et al 1999). It is an essentially dynamic system, its path and flow constantly changes with time (Warner 1983).

The riparian inventory system has been widely evolved from the early meetings on 1970’s (Johnson & McCormick 1978), when riparian zones were considered as distinct landscapes of the riverbank (Odum 1978). The riparian habitat supports the surrounding fluvial ecosystem throughout its entire length and integrates interactions between the aquatic and terrestrial components of the landscape. It is therefore crucial to the preservation of river biodiversity (Ward 1989; Ward et al 2002; Naiman et al 2005; Corenblit et al 2007). Moreover, riparian areas provide flood attenuation and serve to decrease hydrological risks (Horn & Richards 2006). Also, there are lots of trees that could be observed in riparian zones which have roots. Roots increase substrate cohesion, and stems and leaves modify bed roughness, thereby controlling sediment erosion, transport and deposition, both in the channel and in the floodplain (Gurnell & Petts 2002, 2006; Corenblit et al 2008, 2009).

The increasing human population along with the progress of industrialization, different deformations of the landscapes of the riverbanks disrupt ecological balance. The removal of riparian vegetation reduces concentration of dissolved oxygen (Welch et al 1998). The riparian forests also play an important role in the landscape by providing plant and wildlife habitat, increasing landscape connectivity, and protecting water quality (Gilliam 1994). Several characteristics of the physical structure of rivers and streams are extremely important to the quality of habitat for the aquatic life which has been disturbed by different human activities. The nature also undergoes different changes. To have current data about changes in the riparian zone, this system was invented.

Assessment of the water quality by water testing will help to avoid further introduction of pollutants in the river. Through this study, the community living at Lun Padidu will have the knowledge of their activities affecting the health of the river ecosystem and the water quality of it. With this, their local government could implement strict laws and regulations regarding their activities. This would also help to create environmental policies. Monitoring management together with strict environmental policies

implementation help to lessen further future human impact on bodies of waters and natural ecosystems.

## Material and Method

***Study area***. This study was carried out on three sites on Lun Padidu river, at Sarangani Province located at southeastern Mindanao, on July 5-6, 2014 for the RCE and August 20, 2014 for water testing. The precise locations of the bridge and the three sampling sites (which were the area 1, area 2 and area 3) were identified using the Global Positioning System (GPS) (Table 1, Figure 1). These areas are considered as the study sites for the following reasons: there is no riparian study that was conducted on the said place, the ecosystem present in the said place is rich in different species and to establish different protocols for the protection of the river.

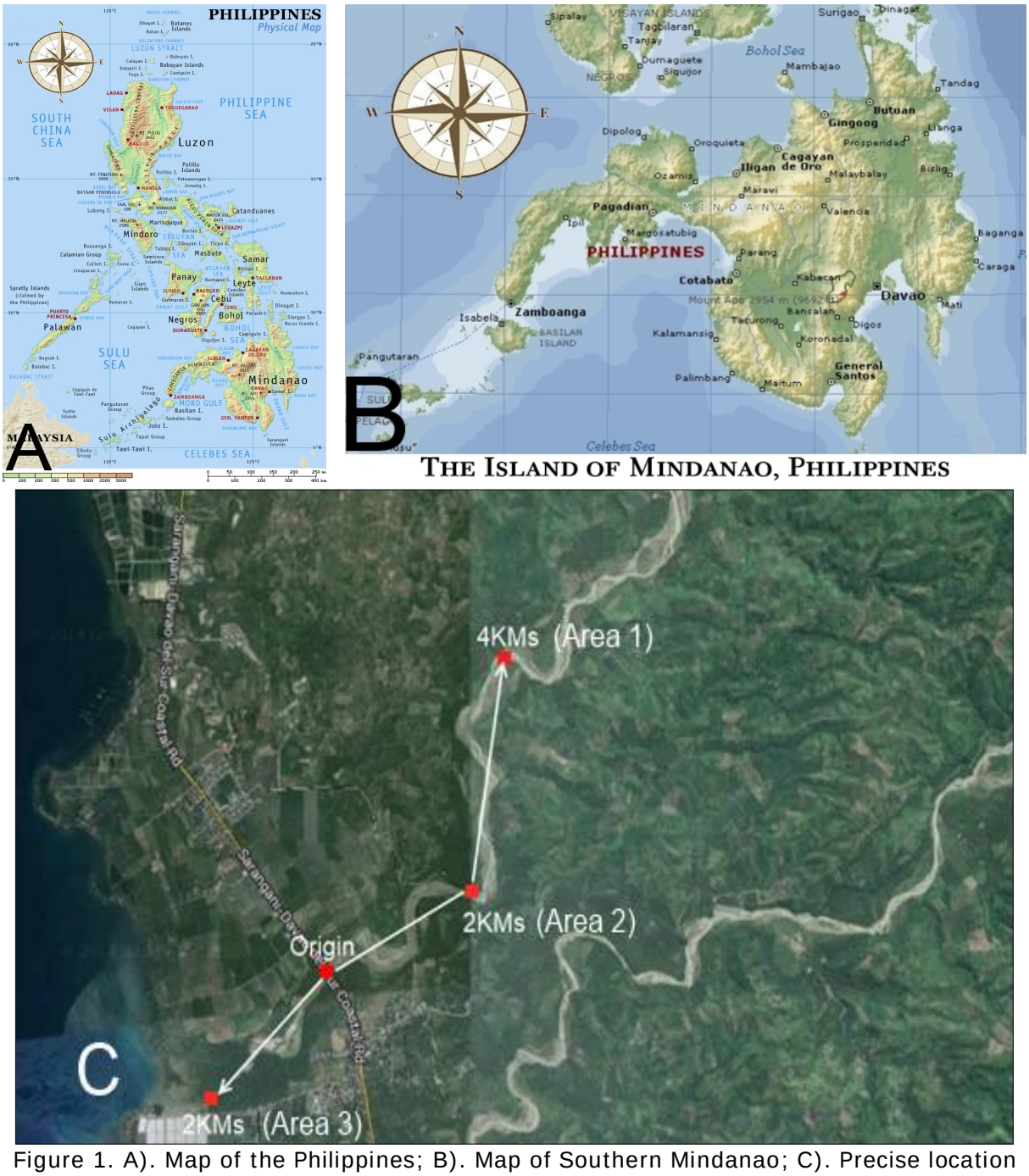


Figure 1. A). Map of the Philippines; B). Map of Southern Mindanao; C). Precise location of the three sampling areas (Source: https://maps.google.com).

Table 1

The precise location of the areas and the bridge

| *Sampling sites* | *GPS coordinates* | |
|---|---|---|
| | *Latitude* | *Longitude* |
| Origin point (Lun Padidu Bridge) | 06°02.5012'N | 125°17.3729'E |
| Area 1 (4 kms upland) | 06°02.7073'N | 125°17.5189'E |
| Area 2 (2 kms upland) | 06°02.2601'N | 125°17.8735'E |
| Area 3 (2 kms downland) | 06°02.1802'N | 125°16.9097'E |

***Riparian Channel and Environmental inventory***. There were factors which are land use, physical structure and biota that were considered under different characteristics that were primarily result of the inventory was taken by means of rating the factors according to their appropriate conditions that are observable in the zone (Table 2).

Table 2

The RCE scoring

| *Factors* | *Categories* | *Highest possible score* |
|---|---|---|
| Land use | land-use pattern | 30 |
| | width of riparian zone | 30 |
| | completeness of riparian zone | 30 |
| | vegetation of riparian zone | 25 |
| | Total | 115 |
| Physical structure | debris dams | 15 |
| | channel width to depth ratio | 15 |
| | stream-bank stability | 25 |
| | bank undercutting | 20 |
| | stony substrate; feel and appearance | 25 |
| | stream bottom | 25 |
| | riffles and pools | 25 |
| | Total | 150 |
| Biota | aquatic vegetation | 15 |
| | fish | 20 |
| | detritus | 25 |
| | Total | 60 |
| | Overall total | 325 |

***Parameters of water testing***. These parameters (dissolved oxygen, total dissolved solids, pH, temperature and salinity) are used to indicate the status of the river water. They also contribute to assess the riverbank conditions because the water is the primary source of survival of the life forms depending on it. Different standard levels for water parameters are set by different studies to rapidly assess the water's status (http://fosc.org; http://fondriest.com; McNeil & Clarks 2004; Alabaster & Lloyd 1980) (Table 3). The standard time of corresponding samples taken were also recorded (Table 4). Although, it is not the basis whether the water is potable or not, it will to avoid the further intruding of different harmful chemicals that could affect the life forms depending on it.

Table 3

Normal values of the physico-chemicals parameters

| *Normal values of parameters* | | |
|---|---|---|
| *Parameters* | *Unit* | *Values* |
| Dissolved oxygen | mg $L^{-1}$ | 7-11 |
| Total dissolved solids | ppm | 0.47-0.50 |
| pH | (su) | 6.5-8.0 |
| Salinity | µS $cm^{-1}$ | 250-500 |
| Temperature | $^{o}C$ | 25-35 |

**Results and Discussion**. On the three sites, there were different ratings of score. The scoring was done by observing the zone. In the area 1 (4 kms upland), the land use got 95 points, the physical structure of river has 110 points and the biota has 40 points. The area 2 (2 kms upland) has 95 points in land-use, physical structure of river has 100 points and the biota has 35 points. Area 3 (2 kms downland) has 85 points in land-use, 96 points for physical structure of river and 45 points for biota (Table 4).

Table 4

RCE scores given to each area

| *Factors* | *Categories* | *Area 1* | *Area 2* | *Area 3* |
|---|---|---|---|---|
| Land use | land-use pattern | 30 | 30 | 20 |
| | width of riparian zone | 20 | 20 | 20 |
| | completeness of riparian zone | 20 | 20 | 20 |
| | vegetation of riparian zone | 25 | 25 | 25 |
| | Total | 95 | 95 | 85 |
| Physical structure | debris dams | 10 | 10 | 1 |
| | channel width to depth ratio | 10 | 10 | 10 |
| | stream-bank stability | 5 | 5 | 5 |
| | bank undercutting | 15 | 15 | 5 |
| | stony substrate; feel and appearance | 25 | 15 | 25 |
| | stream bottom | 25 | 15 | 15 |
| | riffles and pools | 15 | 20 | 20 |
| | Total | 105 | 90 | 81 |
| Biota | aquatic vegetation | 15 | 10 | 15 |
| | fish | 15 | 15 | 20 |
| | detritus | 10 | 10 | 10 |
| | Total | 40 | 35 | 45 |
| | Overall total | 240 | 220 | 211 |

The results of the data taken from each area for DO, pH, temperature and TDS were recorded in Tables 5, 6 and 7.

Table 5

Results gathered from Area 1

| *Parameters* | *1st sample* | *2nd sample* | *3rd sample* | *Mean* |
|---|---|---|---|---|
| Dissolved oxygen | 6.8 | 6.4 | 5.26 | 6.15333 |
| pH | 8.1 | 8.1 | 8.2 | 8.13333 |
| Temperature | 30.1 | 30.1 | 30.7 | 30.3 |
| TDS | 2380 | 2360 | 2380 | 2373.33 |

Table 6

Results gathered from Area 2

| *Parameters* | *1st sample* | *2nd sample* | *3rd sample* | *Mean* |
|---|---|---|---|---|
| Dissolved oxygen | 5.9 | 6 | 5.3 | 5.73333 |
| pH | 7.2 | 8 | 8 | 7.73333 |
| temperature | 30.3 | 29.8 | 31.1 | 30.4 |
| TDS | 2390 | 2380 | 2360 | 2376.67 |

Table 7

Results gathered from Area 3

| *Parameters* | *1st sample* | *2nd sample* | *3rd sample* | *Mean* |
|---|---|---|---|---|
| Dissolved oxygen | 6.9 | 7.5 | 6.9 | 7.1 |
| pH | 8.2 | 8.3 | 8.3 | 8.26667 |
| Temperature | 29.4 | 28.9 | 28 | 28.7667 |
| TDS | 2810 | 3070 | 2930 | 2936.67 |

For salinity, the area 1 and area 2 have 15 practical salinity unit (PSU) and the area 3 has 30 PSU; the area 3 is located in the end portion of the river going to the sea. The overall results and the mean or average of each physico-chemical properties of the corresponding areas are shown in the Table 8.

Table 8

The mean or average of each physico-chemical properties of the corresponding areas

| *Physico-chemical properties* | *Area 1* | *Area 2* | *Area 3* |
|---|---|---|---|
| Dissolved oxygen | 6.15 | 5.73 | 7.2 |
| pH | 8.13 | 7.73 | 8.27 |
| Temperature | 30.03 | 30.4 | 28.77 |
| TDS | 2373.33 | 2376.67 | 2936.67 |

**Conclusions**. The result reveals that the water in Lun Padidu river has the quality of passing the standard levels of the physico-chemical properties set by the DENR Philippines. The RCE result reveals that the classification of the riparian zone of the Lun Padidu is under the very good which scores 232 points. Evidently, it has been shown that the Lun Padidu river is seemingly untouched by industrialization and infrastructure domination. Although, it is still highly recommended to have policies and regulations to be implemented by the local government of the said place to maintain the preservation of the riparian zone but the instillation of a sense of ownership and value in the local population was the first step towards the rational utilization of riparian resource and the water in the river must be monitored regularly for the early detection of pollutants and irregularities of different factors that affect its cleanliness.

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