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Assessment of the riparian vegetation along the riverine systems in Iligan City, Philippines

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Abstract. Riparian forests are forests which occur adjacent to streams, lakes and other surface waters. Through the interaction of their soils, hydrology, and biotic communities, riparian forests protect and improve water quality, provide habitat for plants and animals, support aquatic communities, and provide many benefits to humans (Klapproth & Johnson 2009). A total of 32 species of plants belonging to 15 families were listed and identified along the riparian areas of Mandulog and Iligan City rivers.
Key Words: Riparian, vegetation, Mandulog River, Iligan River, riverine system.

Introduction. Riparian area or zone can be defined 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 1996). The area ranges from emergent aquatic and semi-aquatic plants like terrestrial understorey and canopy species (Parson 1991). Riparian zones play a role in the maintenance of stream and foreshore stability. It is an essentially dynamic system, its path and flow constantly changes with time (Warner 1982). Moreover, the presence of plants in riparian areas acts to reduce the rate of change in a particular area and therefore it maintains a level of stability. Whereas, the removal of the naturally occurring riparian vegetation leads to faster changes.

The word “riparian” comes from the Latin *ripa*, which means “bank,” referencing the fact that the riparian zone begins at the banks of a natural course of rivers. Riparian zones typically consist of vegetated corridors adjacent to stream channels which are ecologically diverse and contribute to the health of aquatic ecosystems by filtering out pollutants. These areas are considered effective natural barriers, which prevent agricultural pollution from being exported and contaminating the larger ecosystem (www.freedictionary.com).

Riparian vegetation indirectly influence the water quality of the adjacent water body as it filters runoff, collect organic matter content, and provides protection of the soil surface from wind and water erosion, stabilize streambanks and changes temperature, light and humidity (Klapproth & Johnson 2009).

The total effects of urban areas on riparian zones can decrease the water quality entering local streams, and ultimately will affect impact drinking water reservoirs of local cities. The results of the Water Quality Corridor Management (WQCM) model showed that subwatersheds that had little urbanizing development tend to have vegetated riparian corridors, with varying degrees of slope, erosivity and floodplain protection. They had scores on the upper half of the subwatershed scores while those with the highest levels of urbanizing development tend to have little vegetation in the riparian corridors and no matter what the levels of the other parameters are, they rarely scored in the upper half of the preservation priority (Atkinson et al 2010).

In agricultural watershed, the quality of water is affected by riparian and channel morphology. The areas with devoid of riparian vegetation and unstable substrates showed an increased concentration of the water quality parameters. High levels were predicted where the presence of unstable channel substrates occurred, and the stream's potential energy was high because of stream alterations such as the removal of stream vegetation along the sides and creation of a uniform, straight channel (Schlosser & Karr 1981).

The objective of this study is to determine the assemblage and community indices of the riparian vegetation along the riverine systems (Mandulog and Iligan rivers) of Iligan City (Figure 1 & 2).

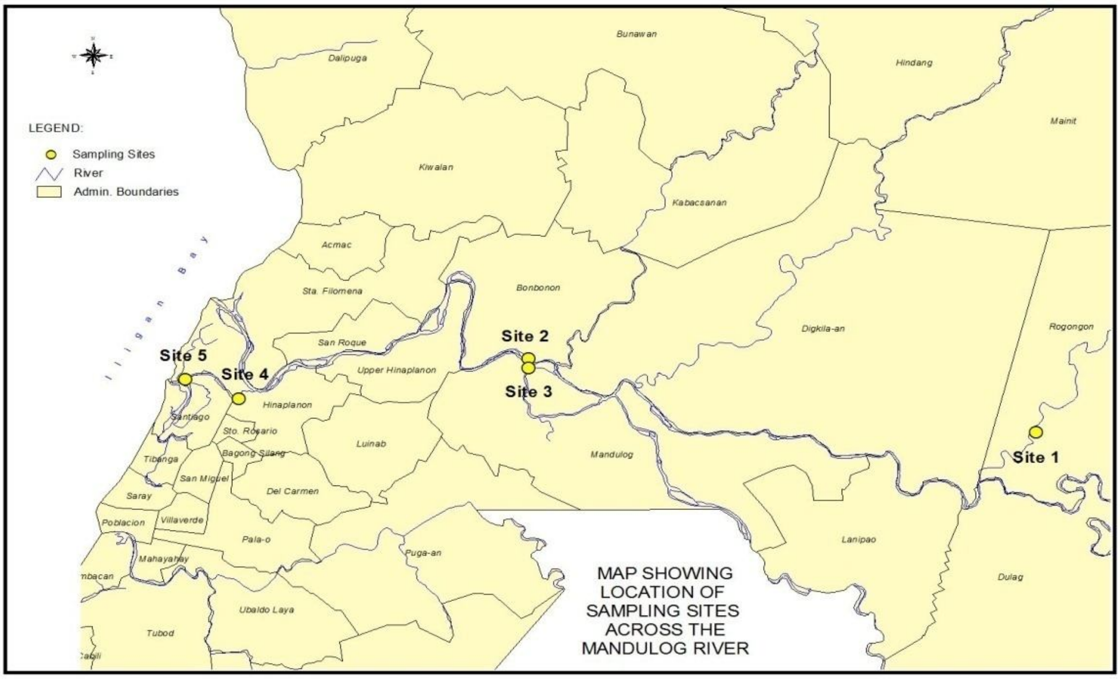

Figure 1. Map showing the sampling sites in Mandulog River in Iligan City.

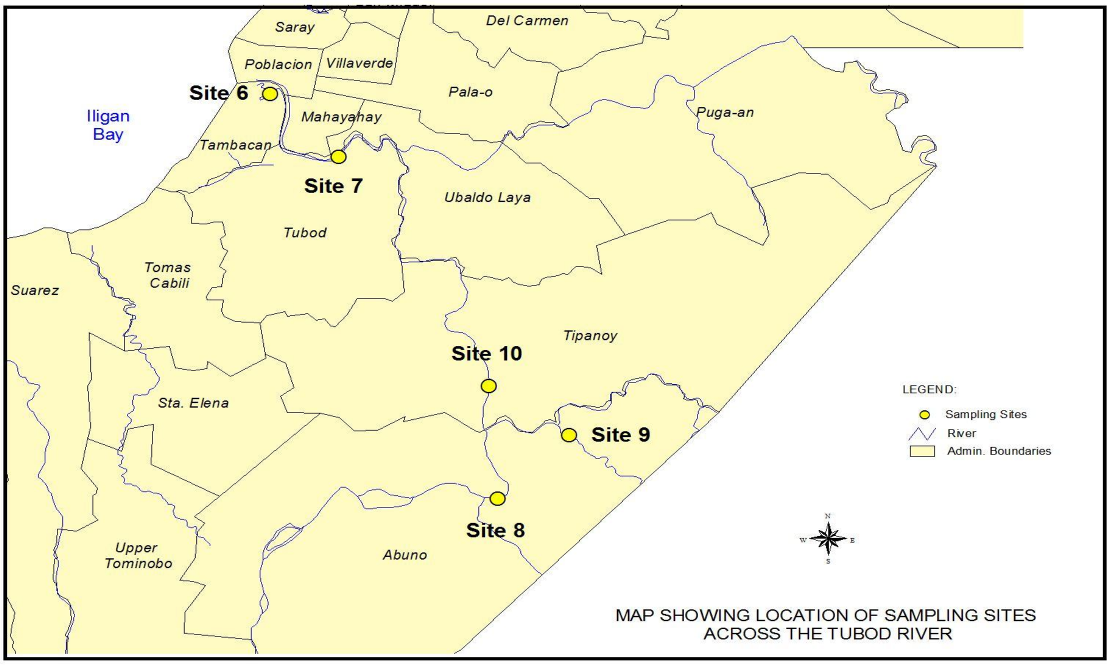

Figure 2. Map showing the sampling sites in Iligan (Tubod) River in Iligan City.

Material and Method. Iligan City is called the "City of Waterfalls", is bounded on the north by the 3 municipalities of Misamis Oriental (namely Lugait, Manticao and Opol), to the south by the 3 municipalities of Lanao del Norte (Baloi, Linamon and Tagoloan) and the 2 municipalities of Lanao del Sur (Kapai and Tagoloan II), to the northeast by Cagayan de Oro City, to the east by the municipality of Talakag, Bukidnon, and in the west by Iligan Bay.

Vegetation Cross-Section Composition (Winward 2000) was used to assessed the five station points were established perpendicular to the riparian complex in each of the rivers in such a way as to cross the entire riparian area (Figure 1 & 2). Geographic locations were also recorded using a GPS device in each station.

A greenline sampling method was also conducted along the sampling stations of the two rivers, where the first perennial vegetation that forms a lineal grouping of community types on or near the water's edge where identified and listed. A greenline transect was established starting on the right-hand side looking downstream and proceeds down the greenline using a step transect approach as described in the cross-section measurement. For each greenline measurement, steps were taken to total a minimum of 50 meters lineal distance on each side of the stream. This minimum distance aided to encompass the potential variation within a riparian complex. Plants found along the greenline transect were identified and recorded.

Results and Discussion. Table 1 reveals that there are about 5 different vegetation types found along the riparian zones of Sitio Kabangahan, Rogongon: 1) herbaceous perrenials, which includes *Colocasia esculenta* (Linn.) Schott*.,* and *Crassocephalum crepidioides* (Benth.) S. Moore; 2) groundcover understorey plants, which includes *Centrosema pubescens* Benth., *Mimosa pudica* Linn.*,* and *Euphorbia hirta* Linn.*;* 3) woody shrubs, which includes *Solanum* sp. and *Gliricidia sepium* (Jacg.) Kunth ex Walp.; 4) vines, which includes *Mikania cordata* (Burm. f.) B. L. Rob.; and 5) grassland community, which includes species under Family Poaceae.

Table 1

Components of the riparian vegetation in Kabangahan, Barangay Rogongon

Family name	*Scientific name*	*Composition mean %*	
		Dry season	*Wet season*
	Herbaceous perennials		
Amaranthaceae	*Amaranthus spinosus* Linn.	1.02	4.16
Cyperaceae	*Cyperus imbricatus*	0.41	2.86
Asteraceae	*Crassocephalum crepidioides* (Benth.)	11.42	17.07
	Vines		
Asteraceae	*Mikania cordata* (Burm. f.) B. L. Rob.	11.42	17.07
Papilionaceae	*Centrosema pubescens* Benth.	9.39	7.23
	Grassland communities		
Poaceae	*Cynodon dactylon* (Linn.) Pers.	53.82	46.49
	Woody shrubs		
Solanaceae	*Solanum* sp.	3.84	6.74
Fabaceae	*Gliricidia sepium* (Jacg.) Kunth ex Walp.	2.93	3.13
Verbenaceae	*Lantana camara* Linn.	7.15	7.01
	Aroids		
Araceae	*Colocasia esculenta* (Linn.) Schott.	3.52	1.51
	Groundcover plant communities		
Euphorbiaceae	*Euphorbia hirta* Linn.	1.42	1.11
Mimosaceae	*Mimosa pudica* Linn.	5.09	2.69

Vetiver grass, a tough, natural, non-invasive plant with a deep penetrating fibrous root structure, is abundant in both sides of the riparian zones which is an efficient system for erosion control, water conservation and soil stabilization. Vetiver grass is also an “ecological-climax” species which outlasts its neighbors and seems to survive for decades showing no aggressiveness or colonization ability and withstands drought and high levels of flooding. Also present along the riverbanks are some mahogany (*Swietenia macrophylla)*, ipil-ipil (*Leucaena leucocephala*), and acacia trees (*Samanea saman*) which provide shelter to the riparian complex.

The riparian vegetation in Caluda is dominated by grassland communities (Table 2), where species under Family Poaceae dominantly covers the left greenline area which sufficiently slows surface runoff to deposit the main portion of its sediment load before reaching a watercourse. Hence, it acts to reduce the initial impact of rainwater on the soil. On the other hand, the right greenline area is prone to soil erosion due to lack of vegetation cover and periodical extraction of sand and gravel. A sandbar is also found in the mid-stream area due to the particulate matter that is mobilized by the rain impact or by water flowing over the surface of the soil.

Table 2

Components of the riparian vegetation in Caluda, Barangay Bonbonon

Family name	*Scientific name*	*Composition mean %*	
		Dry season	*Wet season*
	Herbaceous perennials		
Amaranthaceaa	*Amaranthus spinosus* Linn.	0.38	5.11
	Grassland communities		
Poaceae	*Eleusine indica* (Linn.) Gaertn.	99.62	94.27
	Groundcover plant communities		
Mimosaceae	*Mimosa invisa*	-	0.63

About 2 types of communities are present in Kapay, barangay Upper Hinaplanon (Table 3) riparian vegetation: the grassland community and the herbaceous perennials. The plant communities in both riverbank areas are not effective in retaining soil stability, hence, it is susceptible to erosion and riverbank landslides.

Table 3

Components of the riparian vegetation in Kapay, Barangay Upper Hinaplanon

Family name	*Scientific name*	*Composition mean %*	
		Dry season	*Wet season*
	Herbaceous perennials		
Asteraceae	*Crassocephalum crepidioides* Benth.	19	16.3
	Grassland communities		
Poaceae	*Eleusine indica* (Linn.) Gaertn.	80	35.3

The stream-flow velocity along Bayug is characterized as slow, and on both sides of the riverbanks are residential houses. The presence of aquatic plants (i.e. water lilies) along the riverbanks also contributes to the slow velocity of the water. Cogon grasses (Table 4) are abundant along the right riverbank are embedded with some non-biodegradable garbage. Giant bamboos also aid soil retention and soil stability. The riparian complex is sheltered with mango, coconut, acacia, and gmelina trees.

Riparian lands that removed pollutants is attributed to filtration, deposition, adsorption and absorption where these processes synergistically operate i.e. infiltration of overland flow which leads to increased deposition rates thus the opportunity for adsorption (Cooper & Williamson 1993). The process of erosion is slowed through the reduction of surface flows and rainwater impact, thus effectively filters out suspended particles (Hairsine & Grayson 1992; Allen 1978), and runoff also allows nutrients to be consumed by bacteria attached to buffer material (Hairsine & Grayson 1992; Allen 1978). Riparian vegetation can collect sediments, and together with microbial and chemical degradation processes can bind and biodegrade chemicals and nutrients thus giving a wide spectrum of filtering effect against non-point source pollution events (Odum 1990).

Table 4
Components of the riparian vegetation in Bayug, Barangay Hinaplanon

Family name	*Scientific name*	*Composition mean %*	
		Dry season	*Wet season*
	Herbaceous perennials		
Asteraceae	*Crassocephalum crepidioides* Benth.	9.49	33.78
	Trees		
Mimosaceae	*Leucaena leucocephala* (Lam.) de Wit	6.46	5.29
Fabaceae	*Samanea saman*	7.58	3.97
Arecaceae	*Cocos nucifera* Linn.	12.93	7.95
	Grassland communities		
Poaceae	*Imperata cylindrica* (Linn) P. Beauv.	60.20	27.83
	Aroids		
Araceae	*Colocasia esculenta* (Linn.) Schott.	3.33	2.18

Table 5 shows the Mandulog River mouth riparian vegetation where it is dominated by mangroves on the left riverbank which protects shorelines and riverbanks and acts as a sanctuary for some marine organisms, while the riverbank on the right side is not stable due to poor vegetation.

Table 5
Components of the riparian vegetation in Mnadulog River mouth, Barangay Hinaplanon

Family name	*Scientific name*	*Composition mean %*	
		Dry season	*Wet season*
	Mangrove community		
Rhizophoraceae	*Rhizophora apiculata* Blume	92.19	88.57
	Trees		
Arecaceae	*Cocos nucifera* Linn.	7.81	11.43

The riparian complex along the Tambacan estuary is nested with a residential area on the right riverbank, where residents utilize the riparian area as natural latrine, and a commercial area on the left riverbank where sewerage and market wastes are dumped. The left riverbank is also reinforced with concrete dikes which aids in the stability of the riverbank. Riparian vegetation is very poor in both sides of the riverbanks with few trees standing such as coconut (*Cocos nucifera*), talisay (*Terminalia catappa*), and acacia (*Samanea saman*).

Grassland community dominantly covers the riparian complex of both sides of the riverbanks in Tubod sampling sites (Table 6). But due to consistent manmade destructive activities such as gravel and sand extraction and habitation of illegal settlers along the buffer zones, these made the riparian complex very weak to sustain soil stability. Hence, the river slowly widens and buffer zones are gradually diminishing. Some of the grass species are gradually removed in the greenline due to high stream velocity, erosion and flooding.

The right riverbank side of the Abuno, riparian vegetation is abundant with giant bamboos (Table 7) which are good for soil retention and erosion control. It also provides shelter to the riverbank, causing the slow-velocity beneath the bamboo. The presence of some log debris in the sampling sites provides some measure of refuge to other aquatic inhabitants such as fishes, water striders, and mollusks. Meanwhile, grassland community covers the left riverbank. Along the riverbanks are trees such as talisay and gmelina which also provides shelter to the riparian complex.

Table 6

Components of the riparian vegetation in Tubod bridge, Barangay Tubod

Family name	*Scientific name*	*Composition mean %*	
		Dry season	*Wet season*
	Herbaceous perennials		
Cyperaceae	*Cyperus imbricatus*	-	8.13
	Vines		
Asteraceae	*Mikania cordata* (Burm. f.) B. L. Rob.	-	23.53
	Grassland communities		
Poaceae	*Brachiaria mutica*	100	61.90
	Woody shrubs		
Solanaceae	*Solanum* sp.	-	0.67
	Groundcover plant communities		
Marsileaceae	*Marsilea minuta* Linn.	-	5.77

Table 7

Components of the riparian vegetation in Abuno, Barangay Abuno

Family name	*Scientific name*	*Composition mean %*	
		Dry season	*Wet season*
	Aroids		
Araceae	*Colocasia esculenta* (Linn.) Schott.	12.35	9.42
	Woody shrubs		
Verbenaceae	*Lantana camara* Linn.	6.45	4.04
	Grassland communities		
Poaceae	*Axonopus compressus* (Swartz) P. Beauv.	81.20	86.54

The occurrences of erosion along the left side of the riverbank in the Pindugangan (Table 8) sampling sites proved that the soil in the riverbank is not stable. This could be due to poor riparian vegetation along the riverbank. Coconut and banana plantations present in the riparian complex could not hold the soil.

Table 8

Components of the riparian vegetation in Pindugangan, Barangay Tipanoy

Family name	*Scientific name*	*Composition mean %*	
		Dry season	*Wet season*
	Aroids		
Araceae	*Colocasia esculenta* (Linn.) Schott.	9.09	20.73
	Grassland communities		
Poaceae	*Bambusa textilis* var. *gracilis*	41.82	24.37
	Herbaceous perrenials		
Musaceae	*Musa sapientum* (Linn.)	21.82	12.43
Asteraceae	*Synedrella nodiflora* (Linn.) J. Gaertner	-	26.93
	Trees		
Mimosaceae	*Leucaena leucocephala* (Lam.) de Wit	6.00	6.00
Arecaceae	*Cocos nucifera* Linn.	16.36	9.32

The Tipanoy riparian vegetation is dominated by grassland community (Table 9) that also covers the vast areas of the buffer zones. Fecal materials of grazers such as carabaos (water buffalo) and cows are also present in the area which may contribute to the aquatic detritus. On the right side of the riverbank, a coconut plantation and a population of giant bamboos are planted where the stream underneath are utilized by local residents as natural laundry area.

Table 9

Components of the riparian vegetation in Tipanoy, Barangay Tipanoy

Family name	*Scientific name*	*Composition mean %*	
		Dry season	*Wet season*
	Trees		
Arecaceae	*Cocos nucifera* Linn.	23.61	17.56
	Groundcover plant communities		
Euphorbiaceae	*Euphorbia hirta* Linn.	6.94	6.60
	Grassland communities		
Poaceae	*Cynodon dactylon* (Linn.) Pers.	69.44	75.84

Table 10 shows the community types between Mandulog and Iligan Rivers. The results of the statistical analysis revealed that aroids is positively significant at 1.72 ($0.05 < \alpha \leq 0.10$) while mangroves is highly significant at -2.69 ($\alpha \leq 0.01$). But during the dry season, vines shows -1.87 ($0.05 < \alpha \leq 0.10$), aroids with 2.20 ($0.01 < \alpha \leq 0.05$) and mangroves with -1.87 ($0.05 < \alpha \leq 0.10$) (Table 11). While in the wet season, mangroves (1.87) and groundcover communities (-1.89) showed a positive significance at $0.05 < \alpha \leq 0.10$ (Table 12).

In Mandulog River, the community types differ in terms of their mean cover. During the dry season, the grassland community has the highest mean cover and the groundcover communities had the least mean cover. While in Iligan River, the grassland communities had the highest mean cover of 73.11 % while the lowest were the vines and mangrove communities. But during the wet season, the grassland communities showed highest mean covers in both rivers and the groundcover communities (0.89 %) and mangrove (0.00 %) had the least mean covers.

The types of plant species present in a riparian complex are also one of the indicators of degraded riparian vegetation. Riparian vegetation is degraded by the complete removal or modification of native plants. At a local scale riparian vegetation is frequently degraded by clearing or by activities such as cropping, livestock grazing and trampling. On a catchment scale, changes in flow regimes often affect riparian vegetation either directly by drowning, or indirectly through erosion and bank slumping, floodplain alienation, and altered flooding regimes. A major cause of degradation is the introduction of, or invasion by, non-native species. Species new to the flora periodically colonize these succession habitats while other disappears (Owens et al 2001). In some areas the only vegetation present along streams may be exotic species.

Table 10

Comparison of riparian community types between Iligan and Mandulog Rivers according to seasons (wet and dry season)

Community type	*Data from Iligan Rivers n = 24*	*Data from Mandulog Rivers n = 30*	*T value*
	Cover (Mean %)	*Cover (Mean %)*	
Herbaceous perennials	8.66	10.57	-0.56^{ns}
Vines	2.94	3.29	-0.17^{ns}
Grassland communities	67.64	54.59	1.62^{ns}
Woody shrubs	1.40	3.08	-1.34^{ns}
Aroids	6.45	2.95	1.72^{+}
Trees	10.50	6.34	1.46^{ns}
Groundcover communities	2.41	1.09	1.61^{ns}
Mangrove	0.00	18.08	-2.69**

n - number of sampling sites, ns - not significant, + - significant ($0.05 < \alpha \leq 0.10$), ** - highly significant ($\alpha \leq 0.01$).

Table 11
Comparison of riparian community types Iligan and Mandulog Rivers during the dry season

Community type	Data from Iligan Rivers n = 12	Data from Mandulog Rivers n = 15	T value
	Cover (Mean %)	Cover (Mean %)	
Herbaceous perennials	5.45	7.08	-0.48^{ns}
Vines	0.00	3.33	-1.87^{+}
Grassland communities	73.11	58.74	1.25^{ns}
Woody shrubs	1.61	2.78	-0.64^{ns}
Aroids	5.36	1.37	2.20*
Trees	12.72	6.96	1.21^{ns}
Groundcover communities	1.74	1.30	0.38^{ns}
Mangrove	0.00	18.44	-1.87^{+}

n - number of sampling sites, ns - not significant, + - significant ($0.05 < \alpha \leq 0.10$), ∗ - significant ($0.01 < \alpha \leq 0.05$).

Table 12
Comparison of riparian community types Iligan and Mandulog Rivers during the wet season

Community type	Data from Iligan Rivers n = 12	Data from Mandulog Rivers n = 15	T value
	Cover (Mean %)	Cover (Mean %)	
Herbaceous perennials	11.87	14.07	-0.39^{ns}
Vines	5.88	3.24	0.73^{ns}
Grassland communities	62.16	50.45	0.95^{ns}
Woody shrubs	1.18	3.38	-1.17^{ns}
Aroids	7.54	4.54	0.81^{ns}
Trees	8.27	5.73	0.82^{ns}
Groundcover communities	3.09	0.89	1.89^{+}
Mangrove	0.00	17.71	-1.87^{+}

n - number of sampling sites, ns - not significant, + - significant ($0.05 < \alpha \leq 0.10$).

Based on the statistical result (using T-test) on the comparison of riparian community types, *C. esculen*ta are significant (T-value 1.72). Aroids showed positive significance both in the wet and dry seasons. These are thermogenic plant species and are adapted to monsoonal climates and are used as food and medicine (Pardales 1997). Moreover, Lebot (2009) specified that aroids have an optimum temperature of 20 to 35 °C, not drought resistant, waterlogged tolerant and shade tolerant riparian community type. This introduced aroid species is highly present in most of the sampling sites. This may be due to the previous flooding incidents that occurred in the sampling sites which caused the distribution of this aroid and thrive on the eroded riparian zones. This plant is classified as poor substitute for native plant species because it reduces the diversity of native invertebrate communities since native fishes and other organisms are adapted to the continuous leaf fall provided by native plants. *C. esculen*ta (locally named as *gabi*) may also affect river channel structure. Aside from fast-growing, this plant possesses an enlarged, underground stems with adventitious and fibrous roots that can form obstructions and may cause water to be diverted around them into the banks causing erosion.

The lack of plants along the banks may cause poor water quality by increasing turbidity, which will affect aquatic life. Mangrove community, for example, aids in maintaining water quality and clarity by filtering pollutants and trapping sediments originating from the land. They also prevent erosion by stabilizing sediments though their root systems. The mangrove community also provides a source of food, breeding grounds and nurseries for various aquatic organisms such as fishes and crustaceans, thus promoting biodiversity. Fully-grown mangrove trees are also sturdy which can withstand under extreme natural conditions such as flood and typhoon.

Moreover, mangroves which showed high significance are mainly sediment trappers and excellent source of fuelwood due to very high BTU heat. It can also be a source of lumber and livestock feeds, minimize coastal erosion, reducer of high wind velocity on coastal areas, excellent nursery for marine animals and good source of roofing and wall materials (*i.e.* Nipa).

Vines are source of human food and medicine. Some species can be for fibers and cordages and tying purposes as well as handicrafts.

Ground covers are usually plants that creep, sprawl or clump plants whose primary function is to cover the ground in areas like landscapes that are made by man. Furthermore, they can also include shrubs and perennials, if they spread to cover the area and come in a wide range of shapes, sizes, textures and colors. Many bear attractive flowers that add seasonal beauty to their other good characteristics (Davidson 1999). Ground cover communities are one of the most important plant materials that protect the soil against erosive action of raindrops and overland flow (www.dpi.nsw.gov.au). If surface run-off occurs, it is good forage or livestock foods and some are medicinal and ornamental.

Riparian taxa individually showed different significance at different levels. Marsileaceae is positively significant at ($0.05 < \alpha \leq 0.10$) and Euphorbiaceae significant at ($0.01 < \alpha \leq 0.05$). While Amaranthaceae, Fabaceae, Rhizophoraceae, Papilionaceae, Solanaceae, Araceae, and Musaceae showed the highest significance at ($\alpha \leq 0.01$) (Table 13).

Table 13

Comparison of riparian taxa Iligan and Mandulog Rivers according to seasons (wet and dry)

Taxa	*Data from Iligan Rivers n = 24*	*Data from Mandulog Rivers n = 30*	*T value*
	Cover (Mean %)	*Cover (Mean %)*	
Amaranthaceae	0.00	1.61	-2.83**
Asteraceae	6.31	7.18	-0.29^{ns}
Fabaceae	0.00	1.76	-3.76**
Poaceae	67.64	57.61	1.19^{ns}
Rhizophoraceae	0.00	18.08	-2.69**
Cyperaceae	1.02	0.33	1.14^{ns}
Papilionaceae	0.00	1.66	-2.62**
Solanaceae	0.08	1.06	-2.23*
Verbenaceae	1.31	1.42	-0.14^{ns}
Araceae	11.60	4.88	3.05**
Euphorbiaceae	1.69	0.25	2.17*
Mimosaceae	2.14	2.08	0.07^{ns}
Arecaceae	3.21	2.09	0.80^{ns}
Marsileaceae	0.72	0.00	1.79^{+}
Musaceae	4.28	0.00	2.64**

ns - not significant, + - significant ($0.05 < \alpha \leq 0.10$), * - significant ($0.01 < \alpha \leq 0.05$), ** - highly significant ($\alpha \leq 0.01$).

During the dry season, Asteraceae and Araceae showed highest significance at ($\alpha \leq 0.01$) while Fabaceae is significant at ($0.01 < \alpha \leq 0.05$) and Rhizophoraceae, Papilionaceae, and Solanaceae showed only positive significance at $0.05 < \alpha \leq 0.10$ (Table 14). While in the wet season, Fabaceae (-3.02) is highly significant at $\alpha \leq 0.01$ and Amaranthaceae with -2.77 which is significant at $0.01 < \alpha \leq 0.05$ (Table 15). The mean covers of the riparian taxa during the dry and wet seasons showed that Poacaea in Iligan river and

Mandulog had the highest mean cover while Amaranthaceae, Asteraceae, Fabaceae, Rhizophoraceae, Cyperaceae, Papilionaceae, and Solanaceae had the lowest mean cover in Iligan river and Musaceae (dry) and Marsileaceae and Musaceae (wet) in Mandulog river.

Table 14

Comparison of riparian taxa between Iligan and Mandulog Rivers during the dry season

Taxa	*Data from Iligan Rivers n = 12*	*Data from Mandulog Rivers n = 15*	*T value*
	Cover (Mean %)	*Cover (Mean %)*	
Amaranthaceae	0.00	0.36	-1.63^{ns}
Asteraceae	0.00	4.18	-2.80**
Fabaceae	0.00	2.10	-2.57*
Poaceae	73.11	62.65	0.84^{ns}
Rhizophoraceae	0.00	18.44	-1.87^{+}
Cyperaceae	0.00	0.08	-0.89^{ns}
Papilionaceae	0.00	1.88	-1.84^{+}
Solanaceae	0.00	0.77	-1.80^{+}
Verbenaceae	1.61	1.43	0.16^{ns}
Araceae	11.26	2.93	3.05**
Euphorbiaceae	1.74	0.28	1.53^{ns}
Mimosaceae	2.73	2.31	0.27^{ns}
Arecaceae	4.09	2.59	0.61^{ns}
Marsileaceae	nd	nd	-
Musaceae	5.45	0.00	1.92^{+}

nd – no data or very limited data, n - number of sampling sites, ns - not significant, + - significant ($0.05 < \alpha \leq 0.10$), * - significant ($0.01 < \alpha \leq 0.05$), ** - highly significant ($\alpha \leq 0.01$).

Table 15

Comparison of riparian taxa Iligan and Mandulog Rivers during the wet season

Taxa	*Data from Iligan Rivers n = 12*	*Data from Mandulog Rivers n = 15*	*T value*
	Cover (Mean %)	*Cover (Mean %)*	
Amaranthaceae	0.00	2.87	-2.77*
Asteraceae	12.62	10.17	0.46^{ns}
Fabaceae	0.00	1.42	-3.02**
Poaceae	62.16	52.57	0.78^{ns}
Rhizophoraceae	0.00	17.71	-1.87^{+}
Cyperaceae	2.03	0.57	1.27^{ns}
Papilionaceae	0.00	1.45	-1.84^{+}
Solanaceae	0.17	1.35	-1.53^{ns}
Verbenaceae	1.01	1.40	-0.40^{ns}
Araceae	11.93	6.82	1.41^{ns}
Euphorbiaceae	1.65	0.22	1.47^{ns}
Mimosaceae	1.55	1.85	-0.27^{ns}
Arecaceae	2.33	1.59	0.51^{ns}
Marsileaceae	1.44	0.00	1.89^{+}
Musaceae	3.11	0.00	1.91^{+}

Fabaceae growing in many different environments and climates particularly diverse in tropical forests and temperate shrublands with a seasonally dry or arid climate. Preference for sem-arid to arid habitats is related to a nitrogen demanding metabolism. Many species have the ability to colonize barren and marginal lands because of their capacity to "fix" atmospheric nitrogen via a symbiotic association with root-nodulating bacteria, this is just one of several ways in which legumes obtain high levels of nitrogen to meet the demands of their metabolism particularly in the warm temperate regions.

Rhizophoraceae can be found in the sub-tropical to tropical. They are able to survive inundation by salt water twice a day, and in "soil" which is unstable and poor in oxygen (anaerobic) along tropical and subtropical coastlines and brackish estuaries and deltas, where evergreen trees and shrubs thrive in tideland mud or sand flats inundated daily with sea water (www.botgard.ucla.edu).

Papilionaceae found in all climates but mostly between and near the tropics and crops that grow best below 60 °F (15 °C). They are sensitive and need warmer conditions to thrive in a well drained but moisture retentive soil that has been fed from a previous crop such as potatoes (www.organicgardeningpractices.com).

Araceae are distributed in the Old World tropics and north temperate regions. Some species are marsh plants that are widespread. While Musaceae are found in wet tropical lowlands, and ideal soil for them should be well drained but with good water retention capacity. It thrives on soil pH between 5.5 and 6.5 and an average temperature of 81 °F and full sun is also ideal.

Amaranthaceae is a widespread and cosmopolitan family from the tropics to cool temperate regions. Many of the species are halophytes, tolerating salty soils, or grow in dry steppes or semi-deserts. It is used for human consumption as well as food for insects, livestock and is very good erosion controller.

Intensive activities in riparian areas can lead to serious losses of stream habitat and water quality. Natural drainage is interrupted as riparian soils become compacted, sedimentation rates increase, solar radiation increases and stream channels are altered. These alterations would include the removal of streamside vegetation, removing woody debris and boulders from streams for navigation, stream canalization, damming and dredging (U.S.E.P.A. 1995).

Riparian areas that are adjacent to agricultural lands are often converted to productive crop and grazing lands that can increase drainage, reduce competition with other crops for moisture and sunlight, and remove sources of noxious weeds and habitat for wildlife that can damage crops (Osborne & Kovacic 1993). While in urban areas, streams are degraded as they are diverted through stormwater systems, riparian vegetation is removed and the watershed becomes covered by roads, parking lots, and building. Where stormwater once soaked into the ground, it now must flow over hard surfaces, picking up sediments, petroleum products, chemicals, metals and other pollutants and discharging them directly into storm drains and streams (Booth & Reinelt 1994).

Conclusions. A total of 32 species of plants belonging to 15 families were listed and identified along the riparian areas of the designated sampling sites. The riparian areas are mostly dominated by grasses (under Family Poaceae) such as Bermuda grass (*Cynodon dactylon*), carabao grass (*Axonopus compressus*), and palagtiki (*Eleusine indica*). But these species of grasses are characterized by having short, fibrous roots which can be easily plucked out from the soil during flooding. On the other hand, vetiver grasses (*Vetiveria zizanioides*) are found thriving along the riparian areas of Tubod which are good species for flood control due to its sturdy stems and long, clumping roots which can hold the soil firmly.

It can be concluded that the results of this study revealed that the riparian vegetation along river systems of Iligan City is still in good condition. It is therefore recommended by the researcher that there should be a continuous monitoring of the riparian vegetation of riverine systems of Iligan City and tree planting activities along the riverbanks to minimize erosion.

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