SPECIES RICHNESS AND RIPARIAN VEGETATION OF UPPER CHICO RIVER IN BONTOC, MOUNTAIN PROVINCE

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Abstract: The Chico River is the longest and most elaborate river system in the Cordillera Central Range, Northern Philippines but is understudied. Currently, no published research on its biodiversity is available. To contribute to this data gap, we documented the floral diversity of the river. The river harbors high floral richness at 201 species belonging to 172 genera and 76 families. Forest plots have the highest species richness, of which mostly were indigenous and endemic species with few conservation important species while ricefield and residential plots are mostly of weed and non-native species. Consequently, the forestry plots have higher biodiversity indices than residential and rice field plots. These results show that species richness, species composition, dominant species and biodiversity indices are greatly affected by human activities. Less intense human activities (as in the case of forest plots) lead to higher species richness, greater native species composition, dominance of indigenous species, and higher diversity indices. On the other hand, greater intensity of human activities, as in the case of residential and rice field, result in lower species richness, predominantly weed composition, dominant weed species and lower biodiversity indices. Locally, our results provide an empirical evidence on the supposed rich floral diversity of Chico River.

Keywords: forest, human disturbance, residential, rice field

Introduction:

Over its whole course, a river is a vital resource for both animal and plant life as well as human life. The balance of the ecology and biodiversity depends on each and every river. Rivers must therefore be treated as a most valuable good, guarded and protected from any type of contamination or overuse. Rivers connect habitats and are much more valuable to plants and animals than their surface area would suggest. This role of habitat connectivity connects both sides of river banks and upstream and downstream regions (ECRR 2019).

More than 75 percent of the total stream network is made up of the smallest streams or headwaters which are often first and second order streams (Olson and Anderson 2008). They can be classified as perennial streams

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that flow year-round, intermittent streams that flow several months during the year, or ephemeral streams that flow at the surface only periodically (Meyer et al. 2003). Because of their abundance and isolation, their riparian areas contribute to harbor a range of unique and endangered species and may not be found elsewhere in the watershed (Meyer et al. 2007; Richardson et al. 2005). Land use disturbances occurring in the upland or adjacent to streams may alter the species composition, species richness, and abundance of native species in the riparian zone (Moffatt et al. 2004; Boutin and Jobin 1998) particularly the riparian understory layer which is often more sensitive to disturbances than overstory vegetation (Goebel et al. 2006). This may be due to the invasion of exotic species which also has a negative impact on the ecosystem services and functions (Charles and Dukes 2007). For instance, in the study of Whitman (2009) in the riparian areas adjacent to different agricultural land uses in a watershed in Ohio, USA showed a lower understory floral species diversity and high abundance of weedy and invasive species. Similarly, Urgenson (2006) have found a high reduction in the species richness and abundance of native understory herbs, shrubs, and juvenile trees by the invasive Japanese knotweed herbs (*Polygonum cuspidatum*, *P. sachalinense*, and *P. bohemicum*) in riparian forests of the USA. These may suggest that the effect on the reduction of understory riparian tree establishment could have detrimental and long-lasting effects on the successional trajectory of riparian vegetation, bank stability, hydrology, nutrient loading, micro-habitat conditions and aquatic biota of adjacent lotic systems (Urgenson 2006).

The riparian zone ecosystems are among the world's most diverse and dynamic floral habitats (Lind et al. 2019). They are considered as biodiversity corridors because of the diverse collection of valuable species therein (Looy et al. 2017; Atkinson and Lake 2020). Moreover, riparian ecosystems are viewed as a mosaic of habitat patches within which soil moisture, sediment and nutrient properties vary (Capon and Dowe 2012; Dulnuan and Napaldet 2023). Thus, it is very much interesting to understand the floral diversity and distribution patterns of riparian ecosystems. A healthy riparian ecosystem is often indicated by its diverse floral species (Bhat et al. 2016). Another factor that makes the study of riparian zone ecosystem much needed is the high degree of physical disruptions and the irregular distribution and richness of species. At present, the disturbances occur in a range of different levels, frequencies and intensities that are primarily induced by land-use change from agriculture, residential, commercial and industry. These directly reduce the species diversity and affect its composition as well as the plant community structure (Mligo 2017), which in turn result in change to water temperatures, and the alteration of the abundance and diversity of basal food resources (Sargac et al. 2021; Burdon et al. 2020). This clearly indicates that assessment of riparian vegetation is an important indicator of the ecological integrity of rivers.

The Chico River is the longest and most elaborate river system in the Cordillera Central Range that form the backbone of Northern Luzon. Draining a large part of the Central Cordilleras, the Chico flows north from its headwaters at Mt. Data meandering through Mountain Province before it gouges northwest, entering the sub-province of Kalinga, then cuts to northeast to join the Cagayan River which reaches the sea in Aparri (Carino 1980). Amidst its ecological and economic importance, the floral species of this river has never been reported in available literatures. Documenting its floral diversity would serve as important baseline for planning and future conservation efforts.

Materials and methods:

Study Site

The Chico River is the most extensive river in the Cordillera region, covering the provinces of Mountain Province, Kalinga and Cagayan.

It runs 233 km (145 mi) through Mountain Province and Kalinga provinces before merging into the Cagayan River. The river and its tributaries are the lifeblood of indigenous communities in the Cordillera region of the northern Philippines, providing a bounty of fresh water for drinking and for irrigation and wealth of wild flora and fauna. The highest headwaters begin along the slopes of Mount Data in the Cordillera mountains at Bauko, Mountain Province and then flows northeastward through Bontoc, Sabangan and Sadanga in Mountan Province. It continues through Tinglayan, Lubuagan, Tabuk City, Pinukpuk, Tuao, Piat and Rizal in Kalinga, finally arriving at Santo Niño, where it merges with the Cagayan River (Lapniten 2021).

Before the study commence, proper permits were secured first such as the wildlife Gratuitous Permit number (DENR-CAR- 07-2022) in pursuant to Republic Act 9147. Also, approval to conduct the study was given in writing by the municipal mayor of Bontoc.

Sampling Design: Floral Diversity Assessment Method

Along the Upper Chico River in Bontoc, Mountain Province, three sampling stations have been established namely upstream, midstream, and downstream (Fig. 1). In all stations, three major land-uses were identified namely residential, ricefield and secondary forest. In residential and ricefield stations, nine (9) quadrats measuring 1 x 1 m were used to inventory the floral diversity. On the other hand, three (3) nested plots were used in the secondary forest. Each nested plot consist of one 20 x 20 m for trees, two 5 x 5 m for shrubs/tall grass/tree sapling and three 1 x 1 m for herbs/grass/shrub or tree seedling following the recommendation of Balangen et al. (2023) and Guron et al. (2019).

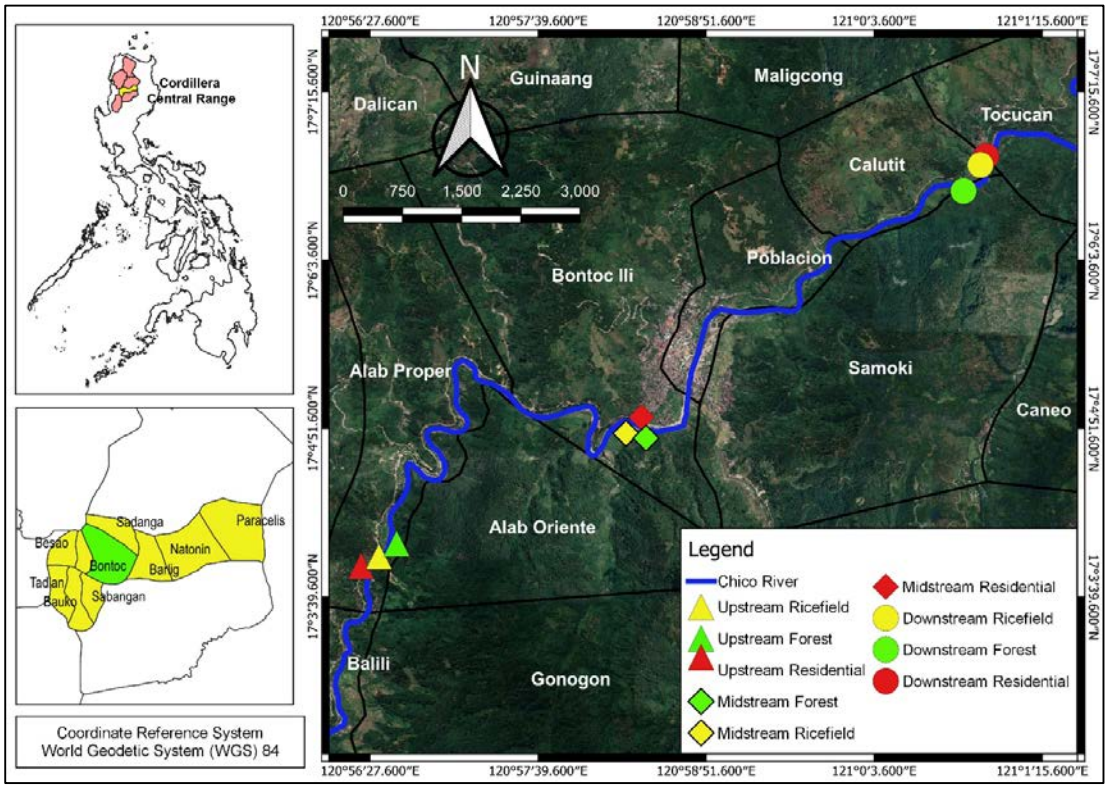
Treatment of Data

Majority of floristic studies and inventories are using plot sampling techniques. It is simple because of the uniform forms of the plots and the random distribution throughout the sampling area. This approach is physically taxing but non-destructive (Napaldet and Buot 2019; Dulnuan and Napaldet 2023). Plants in the different sampling stations was taxonomically identified. Several taxonomic references were used to verify the plants such as the published works of Pancho (1983) and Pancho and Gruezo (2006, 2009). On-line databases generated by Pelser et al. (2011 onwards) and that of tropicos.org (Missouri Tropical Garden 2013) were also consulted. Scientific names and classification were checked and verified in the Plants of the World Online website (Royal Botanical Garden Kew, http:// www.plant softheworld online.org/).

Species richness (S) and Population Counts

Species richness is the simplest measure of biodiversity and is simply a count of the number of different species in a given area. It is commonly used, along with other diversity indices. A given area with high species richness indicates a high level of ecosystem stability; thus, allowing the ecosystem to better withstands natural or anthropogenic disturbances (i.e. fires, floods, disease, deforestation etc.) (Faggetter et al. 2017). Additionally, the species dominance was computed using density, frequency and basal area for trees using standard formulae (Balangen et al. 2023).

Figure no. 1 Bontoc Map showing the sampling stations along Chico River



Diversity Indices

To compare the flora diversity between sampling stations and land-uses, Shannon's Index (H'), Simpsons, Margalef and Jaccard index of similarity were computed. Shannon's Index is commonly used to characterize species diversity in an area. It is affected by both the number of species and their equitability, or evenness. Thus, the greater the number of species and the more even the distribution of species both result in an increase in Shannon's diversity (Faggetter et al. 2017). The maximum Shannon's diversity for a sample is found when all species are equally abundant. It is determined using the formula (Magurran 1988).

$$H = \sum_{i=l}^{S} pi(lnpi)$$

where:

H = Shannon-Wiener diversity index
pi = number of individuals of species i/ total number of samples
S = number of species or species richness

Evenness quantitatively depicts the distribution of species within the area. It is interpreted as 0 with no evenness or complete dominance and 1 with complete evenness or equal distribution. It is calculated as follows:

$$E = \frac{H}{Hmax}$$

where:

E = evenness
H_{max} (maximum diversity possible) = ln (N)

Simpson's diversity index is the complementary of evenness. It is the common measure of dominance with values ranging

from 0 to 1 – 1 represents infinite diversity and 0, no diversity (Barcelona Field Studies Centre 2018). It is computed as follows:

$$D = 1 - \sum_{i=1}^{s} \frac{ni(ni-1)}{N\,(N-1)}$$

where:

D = Simpson's diversity index
ni = total individual of species *i*
N = total number of individuals of all species

Margalef's index is a quantitative contemporary of species richness. It is computed as:

$$R = \frac{(S-1)}{\ln(N)}$$

where:

R = richness
S = # of species
N = # of individuals (of all species)

To compare the diversity among sampling stations, Jaccard index of similarity was used. It was computed as:

$$J = \frac{Sc}{Sa + Sb + Sc}\ x\ 100$$

where:

J = Jaccard index of similarity
Sc = number of species common to the two samples
Sa = number of species unique to station a
Sb = number of species unique to station b

The biodiversity indices calculated were interpreted using Table 1 (Jorgensen et al. 2005; Ulfah et al. 2019).

Table no. 1 Diversity Index and Species Evenness Values and their interpretation

VALUES	INTERPRETATION
Shannon- Wiener (H')	
>3.5000	Very high
3.0000-3.4999	High
2.5000-2.9999	Moderate
2.0000-2.5999	Low
<1.9999	Very Low
Evenness Pielou index (E)	
0.96-1.0	Balanced
0.76-0.95	Almost Balanced
0.51-0.75	Semi-balanced
0.26-0.50	Less balanced
0.00-0.25	Unbalanced
Simpson's index (D)	
0.00	Absence of diversity
0.01-0.40	Low diversity
0.41-0.60	Moderate diversity
0.60-0.80	Moderately high diversity
0.81-0.99	High diversity
1.00	Absolute (perfect) diversity
Margalef's index (R)	
>4	High species richness
2.5-4	Medium species richness
<2.5	Low species richness

Results and discussion:

Species composition and diversity

A total number 201 species belonging to 172 genera and 76 families were documented along Upper Chico River in Bontoc Mountain Province. In terms of major plant categories, 23 species were pteridophytes, 1 gymnosperm, 39 monocots and 138 dicot (Fig. 2). In terms of distribution status, 119 were indigenous species, 15 endemic, 57 naturalized species and 10 exotic species. Few conservation important species were also documented including 1 endangered species, 4 vulnerable species and 2 threatened species (Fig. 3).

Figure no. 2 Floral species, genera and family richness of Chico River in Bontoc, Mountain Province

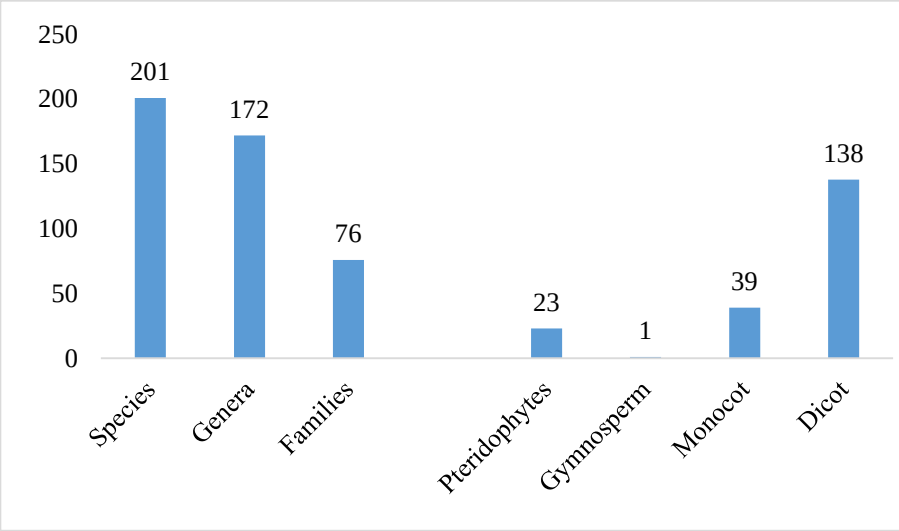
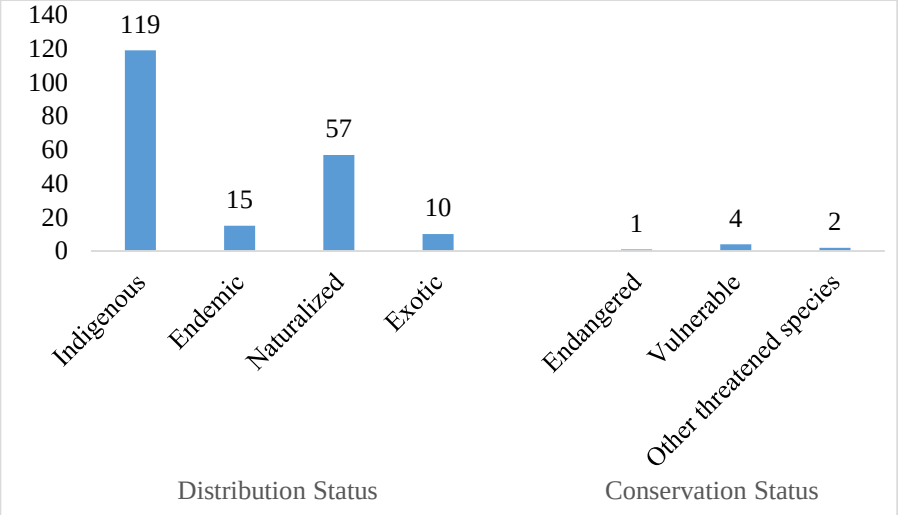
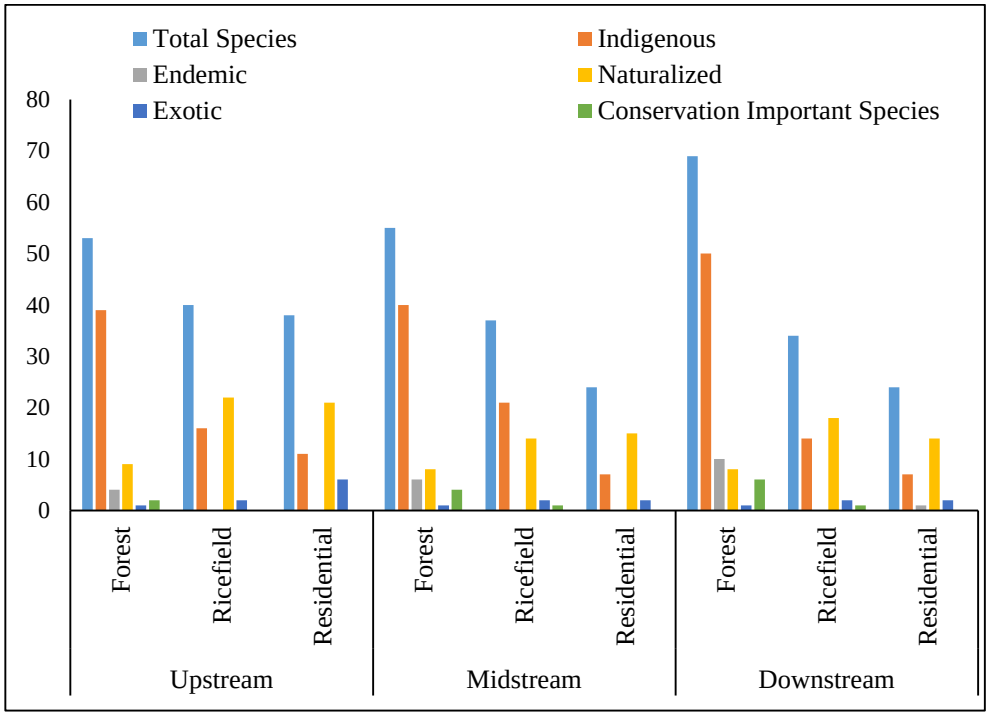


Figure no. 3 Distribution and conservation status of the plants in Chico River in Bontoc, Mountain Province



Species richness differed greatly between land-uses across the sampling stations. Forest stations have the greatest number of species at 53-69 with Tocucan featuring the highest value. Much lower values were recorded in ricefield sites at 34-40 species and residential sites at 24-38 species (Fig. 4). Endemic species and conservation important species were also most noted in the forest stations. On the other hand, majority of the naturalized and exotic species were mostly noted in the ricefield and residential sites.

Figure no. 4 Species richness and classification by sampling station in Chico River, Bontoc, Mountain Province



Family Poaceae is the most represented with 26 species followed by Asteraceae with 16, Fabaceae with 10, Moraceae with 9 and Amaranthaceae with 8. Majority of the families were represented by one or two species (Fig. 5, Annexes).

Dominant Plant Species

The dominant species in the sampling stations were presented in Tables 2 to 10 (Annexes). Tables 2 to 4 (Annexes) cover Alab, the upstream station; Tables 5 to 7 (Annexes) for Lanao, the midstream station; and, Tables 8 to 10 (Annexes) for Tocucan, the downstream station.

The dominant trees in the forest stations across the three sampling stations were characteristics of secondary mid-elevation and riparian forest. In the upstream stations, the dominant trees are *Ficus septica*, *Albizia saponaria*, *Guioa koelreuteria*, *Pittosporum pentandrum*, *Breynia cernua*. These trees suggest an area at an early stage of secondary succession and is most likely since the station was near an abandoned farm. On the other hand, the dominant trees in the midstream station were *Vaccinium cumingianum*, *Prunus fragrans*, *Pinus kesiya*, *P.*

pentandrum and *Macaranga tanarius*. These trees also suggest early stage of secondary succession but farther along than the upstream station. Lastly, the downstream station was dominated by *Ficus balete*, *Wendlandia luzoniensis*, *Ficus ampelas*, *Turpinia ovalifolia* and *Bridelia insulana* with large individuals. These trees suggest the station to be at middle stage of secondary succession.

Similar with dominant trees, the dominant shrubs in the forest stations across the three sampling stations were characteristics of secondary mid-elevation and riparian forest. Tall grasses were included in the shrub inventory and some were found dominant. In upstream, the dominant shrubs and tall grasses were *Leptosolena haenkei*, *Miscanthus floridulus*, *Leea manillensis*, *Lantana camara* and *Guioa koelreuteria* while *M. floridulus*, *Eurya chinensis*, *Prunus fragrans*, *L. haenkei* and *L. manillensis* in mid-stream station. On the other hand, the dominant shrubs in the downstream station were *M. floridulus*, *T. ovalifolia*, *Deutzia pulchra*, *Acalypha amentacea* and *L. manillensis*. The predominance of *M. floridulus* particularly in upstream and midstream stations are clear evidence of the early secondary succession state of the area. The presence and dominance of *Lantana camara* suggest a denuded state of the area but the presence of several indigenous shrubs like *E. chinensis*, *G. koelreuteria*, *P. fragrans*, *T. ovalifolia*, *D. pulchra* and the vulnerable *L. haenkei* are indicative of recovery. Conversely, *L. manillensis* is a known riparian species.

The forest floor under forest stations were dominated by the exotic *Ageratina riparia* plus native species like *Drynaria quercifolia*, *Drynaria speciosa*, *Nephrolepis biserrata*, *Lygodium flexuosum*. This was documented in several other sites in the CCR. On the other hand, ricefield and residential stations were documented by common weeds like *Bidens pilosa*, *Pogonatherum crinitum*, *Ageratum conyzoides*, *Drymaria cordata*, *Centratherum punctatum*, *Tithonia diversifolia*, *Cynodon dactylon*, *Pontederia crassipes*, and *Melinis minutiflora*. The ricefield was under follow period during the inventory so weeds were generally allowed to grow.

Biodiversity Indices

Figure 6 presented the diversity indices of the three sampling stations along Upper Chico River in Bontoc, Mountain Province. Similar with species richness, the highest diversity indices were recorded in forest stations with Shannon index of 3.49-3.62 (high to very high) and Margalef's index of 9.95-12.56 (high diversity). On other hand, ricefield sites are characterized by lower Shannon values at 3.19-3.42 (high diversity) and lowest in residential plots at 2.78-3.40 (moderate to high diversity).

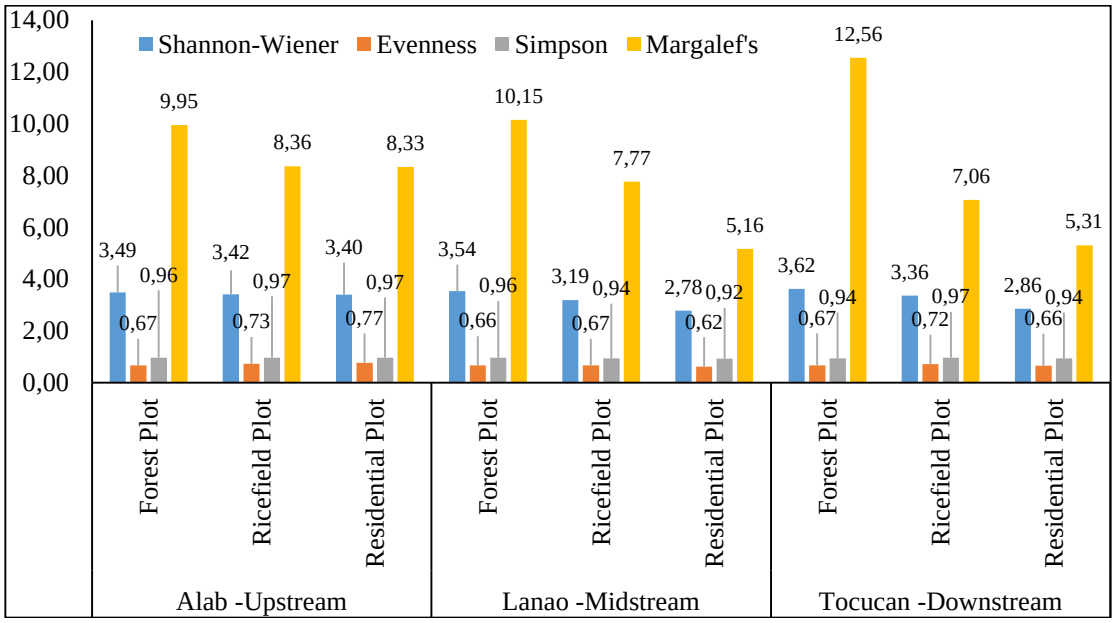
Jaccard index of similarity

The Jaccard index of similarity between stations was presented in Table 11 (Annexes). The index of similarity was higher between plots with the same land use and lower between forest plots and other plots. For example, the index of similarity between forest plots located in different stations ranges at 0.15 – 0.17; and, between ricefield plots in different stations at 0.18 – 0.20. However, the index of similarity between residential plots in different stations varied widely at 0.05 – 0.13 which indicates highly variable plots in residential areas as consequence of human activities. The index of similarity between forest and residential or ricefield plots were consistently low at 0.01 – 0.08 while relatively higher between ricefield and residential at 0.09 – 0.20.

The sampled stations along Chico River register high floral richness at 201 species belonging to 172 genera and 76 families. This number is much higher than recent inventories on water bodies in the Philippines such as the study of Napaldet and Buot (2019) on Balili River, Benguet with 38 species under 37 genera and 19 families, the study of Torrefiel and Buot (2017) on Molawin Creek, Laguna with 52 weed species, belonging to 41 genera in 23 families, and those of Batani et al. (2023) on Palina River, Benguet with 92 species belonging to 84 genera under 42

families. Our result is more comparable with the result of Balangen et al. (2021) on Intek River, Benguet that registered 146 species belonging to 130 genera and 59 families and those of Dulnuan and Napaldet (2023) on Amburayan River, Benguet with 249 species belonging to 200 genera and 74 families. The high species richness in our study could be attributed to the inclusion of three major types of land-use observed in the study site namely residential, ricefield and forest. The species composition differs greatly between forest and the other sites as shown in low similarity index but these contribute to the high over-all species richness. This result provides empirical evidence on the claim of Lapniten (2021) that Chico River harbors rich biodiversity, at least in the case of floral diversity.

Figure no. 6 Species diversity indices of the three sampling stations of Chico River in Bontoc



The biodiversity indices of the forestry plots in our study with Shannon of 3.49 – 3.62, Simpson of 0.94 – 0.96 and Margalef's index of 9.95 – 12.56 are comparable to those derived by Balangen et al. (2021) on Intek River, Benguet with Shannon of 3.92, evenness of 0.56, Simpson's index of 0.95; and, those of Dulnuan and Napaldet (2023) on Amburayan River, Benguet with Shannon of 4.48, an evenness index of 0.57 and Simpson's index at 0.97. On the other hand, the biodiversity indices of residential and ricefield plots with Shannon of 2.76 – 3.40, Simpson of 0.92 – 0.97 and Margalef's index of 5.16 – 8.36 are comparable with those of Batani et al. (2023) on Palina River with Shannon of 3.39, evenness of 0.60 and Simpson's 0.94; but it is higher than those of Napaldet and Buot (2019) on Balili River, Benguet with Shannon of 1.66, evenness of 0.25, and Simpson of 0.84. In most ecological studies, Shannon-Wiener's index ranged between 1.5 and 3.5 with higher number indicating greater species richness and evenness (Fernando and Cereno 2020). These results show the biodiversity indices are much higher in forest plots than residential and ricefield plots.

The species richness of families Asteraceae and Poaceae in the river is not unexpected since these are two of the largest plant families (Pancho and Gruezo 2012).

These families harbor species of certain importance and feature wide distribution. Asteraceae family or sunflower family consists of 1,911 genera and 32,205 species worldwide (Royal Botanical Garden Kew, http://www.plantsoftheworldonline.org/), while Poaceae has 759 genera and 11,554 species. Several species under these families serve as crops, ornamentals and weeds contributing to their wide distribution. In the locality, several species of Asteraceae and Poaceae were observed to be the first to colonize disturbed areas including residential and ricefields. Family Moraceae, on the other hand, was solely represented by nine *Ficus* spp. which are known to thrive in moist habitat and are important reforestation tree species as well as food sources for frugivores (Stier and Mildenstein 2005). Families Fabaceae and Amaranthaceae are mostly represented by weed species known to occur in ricefeilds and other human-dominated areas (Pancho and Obien 1995).

The trees in the forest plots are characteristics of secondary forest undergoing succession which would make the area fall under young secondary forest according to the criteria proposed by Phillips et al. (2017). Nonetheless, several species are indigenous or endemic and few are of endangered or vulnerable status. Some authorities in ecology have suggested that endemic species could be more important information than the overall species composition for conservation purposes (Merrill and Meritt 1910; Killeen et al. 1998; Malabrigo 2013; Guron et al. 2019). Endemic species have narrow distribution and being threatened in its own natural habitat would hasten their extinction since there would be no other source of propagules for their regeneration. These provide further evidence on the notion that Chico River harbors important floral diversity and makes the inventory in this study more interesting and important – it could serve as a baseline for future monitoring to understand the further recruitment of other endemic and conservation important species in the river.

Aside from biodiversity indices, forest plots have significantly higher species richness as well as higher number of indigenous, endemic and conservation important species compared to the residential and ricefield plots. The latter plots, on the other hand, are mostly composed of exotic or naturalized species. These results are consistent with the observation of Guron et al. (2019) that greatly disturbed areas like residential and agricultural areas have lower species richness and weed/exotic species composition while less disturbed areas like secondary forests have higher species and native (indigenous + endemic) species composition. Our results also supports the conclusion of Balangen et al. (2023) that the level of human disturbance is significantly associated with species richness, species composition, dominant species and biodiversity indices. Greater human disturbance, as in the case of residential and ricefield, results in lower species richness, predominantly weed composition, dominant weed species and lower biodiversity indices. On the other hand, lesser human disturbance (as in the case of forest plots) leads to higher species richness, greater native species composition, dominance of indigenous species, and higher diversity indices. The most disturbed land use experienced the greatest loss of species richness, change in floristic composition and vegetation structure, as well as a shift from native to alien-dominated plant communities. These results showed that the effect of land use change is not limited to species richness but also to species composition, dominant species and biodiversity indices.

Conclusions:

Chico River registered high floral richness at 201 species belonging to 172 genera and 76 families that could be attributed to low index of similarity between the floral plots with ricefield and residential plots. Forest plots have the highest species richness, of which mostly were indigenous and endemic species with few conservation important species while weed and non-native species

predominates in the ricefield and residential plots. Consequently, the forestry plots have higher Shannon of 3.49 – 3.62, Simpson of 0.94 – 0.96 and Margalef's index of 9.95 – 12.56 compared to the biodiversity indices of residential and ricefield plots with Shannon of 2.76 – 3.42, Simpson of 0.92 – 0.97 and Margalef's index of 5.16 – 8.36. These results show that that the level of human disturbance is significantly associated with species richness, species composition, dominant species and biodiversity indices. Greater human disturbance, as in the case of residential and ricefield, results in lower species richness, predominantly weed composition, dominant weed species and lower biodiversity indices. On the other hand, lesser human disturbance (as in the case of forest plots) leads to higher species richness, greater native species composition, dominance of indigenous species, and higher diversity indices. Locally, our results provide an empirical evidence on supposed rich floral diversity of Chico River.

Rezumat:

BOGĂȚIA SPECIILOR ȘI VEGETAȚIA RIPARIANĂ DIN CURSUL SUPERIOR AL RÂULUI CHICO ÎN BONTOC, PROVINCIA MOUNTAIN

Râul Chico este cel mai lung și mai elaborat sistem hidrografic din Cordillera Central Range, în nordul Filipinelor, dar este puțin studiat. În prezent, nu este disponibilă nicio cercetare publicată privind biodiversitatea sa. Pentru a contribui la această lipsă de date, am documentat diversitatea floral a râului. Râul adăpostește o bogăție floral ridicată de 201 specii, aparținând la 172 de genuri și 76 de familii. Parcelele forestiere au cea mai mare bogăție de specii, dintre care cele mai multe sunt specii indigene și endemice, cu puține specii importante pentru conservare, în timp ce parcelele de orezărie și cele rezidențiale sunt formate în principal din buruieni și specii alogene. În consecință, parcelele forestiere au indici de biodiversitate mai mari decât parcelele rezidențiale și de orezărie. Aceste rezultate arată că bogăția de specii, compoziția speciilor, speciile dominante și indicii de biodiversitate sunt puternic afectați de activitățile umane. Activitățile umane mai puțin intense (ca în cazul parcelelor forestiere) conduc la o bogăție mai mare de specii, o compoziție mai mare de specii indigene, dominanța speciilor indigene și indici de diversitate mai mari. Pe de altă parte, o intensitate mai mare a activităților umane, ca în cazul parcelelor rezidențiale și al orezăriilor, duce la o bogăție mai mică de specii, o compoziție predominantă de buruieni, specii dominante de buruieni și indici de biodiversitate mai mici. La nivel local, rezultatele noastre oferă o dovadă empirică a presupusei bogate diversități florale a râului Chico.

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Annexes:

Figure no. 5 Plant family representation in Chico River, Bontoc, Mountain Province

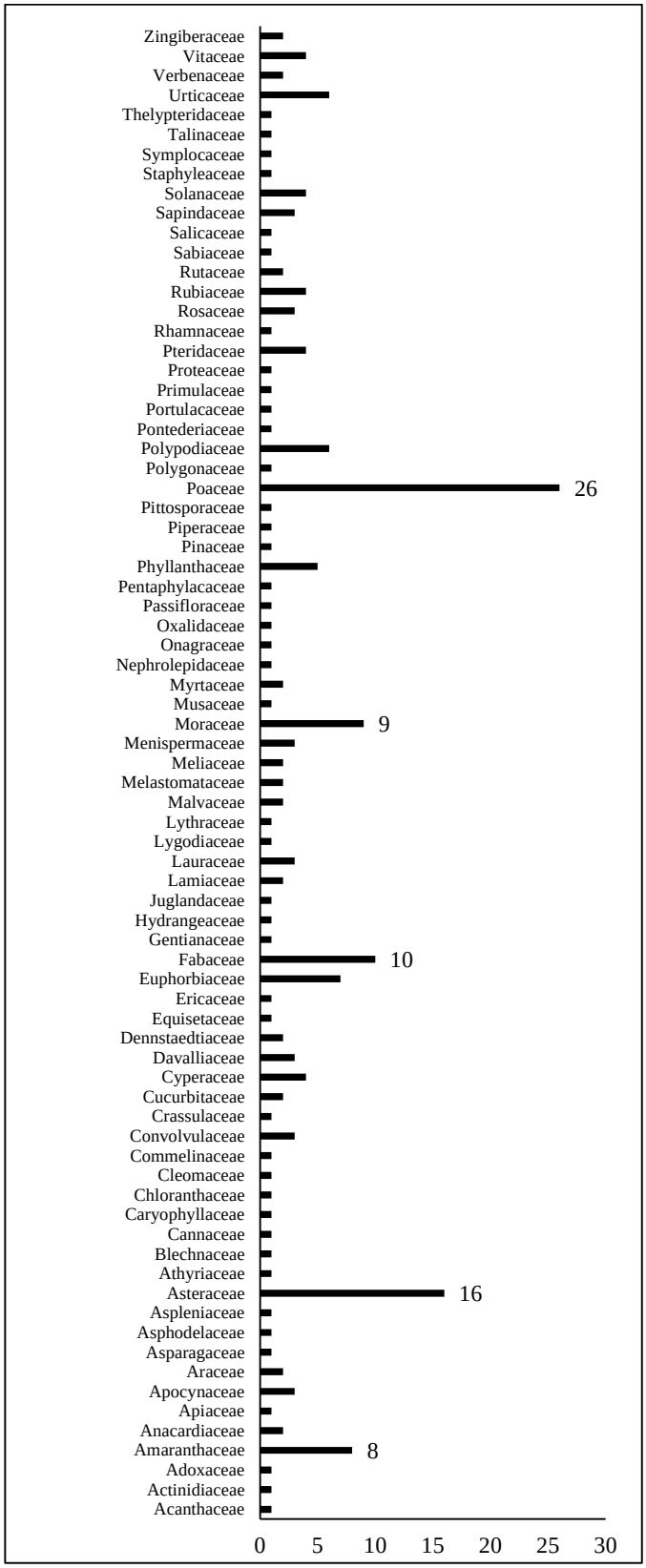

Table no. 2A Population Counts for Trees in Forest Plot along Chico River in Alab, Bontoc as Upstream Station

Trees	CCH	ni	Ji	DBH	Di	Fi	BAi	RDi	RFi	RBAi	IV
Actinodaphne intermedia (Elmer) Kosterm. ex Brambach & Pelser	86	2	2	27.37	0.0017	66.67	4.09	7.14	9.09	0.02	5.42
Albizia saponaria (Lour.) Blume ex Miq.	258.5	4	2	82.28	0.0033	66.67	36.93	14.29	9.09	0.19	**7.86**
Atalantia racemosa Wight & Arn.	28	1	1	8.91	0.0008	33.33	0.43	3.57	4.55	0.00	2.71
Breynia cernua (Poir.) Müll.Arg.	244.5	2	2	77.83	0.0017	66.67	33.03	7.14	9.09	0.17	**5.47**
Bridelia insulana Hance	80	2	1	25.46	0.0017	33.33	3.54	7.14	4.55	0.02	3.90
Ficus cuneiformis C.C.Berg	107	1	1	34.06	0.0008	33.33	6.33	3.57	4.55	0.03	2.72
Ficus nota (Blanco) Merr.	67	1	1	21.33	0.0008	33.33	2.48	3.57	4.55	0.01	2.71
Ficus septica Burm.f.	380.5	4	3	121.12	0.0033	100.00	80.01	14.29	13.64	0.41	**9.44**
Guioa koelreuteria (Blanco) Merr.	163	3	2	51.88	0.0025	66.67	14.68	10.71	9.09	0.08	**6.63**
Leea indica (Burm.f.) Merr.	32	1	1	10.19	0.0008	33.33	0.57	3.57	4.55	0.00	2.71
Mallotus mollissimus (Geiseler) Airy Shaw	26	1	1	8.28	0.0008	33.33	0.37	3.57	4.55	0.00	2.71
Pinus kesiya Royle ex Gordon	96	1	1	30.56	0.0008	33.33	5.09	3.57	4.55	0.03	2.71
Pipturus arborescens (Link) C.B.Rob.	19	1	1	6.05	0.0008	33.33	0.20	3.57	4.55	0.00	2.71
Pittosporum pentandrum (Blanco) Merr.	105	3	2	33.42	0.0025	66.67	6.09	10.71	9.09	0.03	**6.61**
Wendlandia luzoniensis DC.	38	1	1	12.10	0.0008	33.33	0.80	3.57	4.55	0.00	2.71

Note: CCH – circumference at chest height; ni – number of individual of species; Ji – number of plot where the species occur; DBH - diameter at breast height; Di – density of species; Fi – frequency of species; BAi – basal area of species; RDi – relative density of species; RFi – relative frequency of species; RBAi – relative basal area of species; IV – importance value

Table no. 2B Population Counts for Shrub in Forest Plot along Chico River in Alab, Bontoc as Upstream Station

Shrubs	ni	Ji	Di	Fi	RDi	RFi	IV
Actinodaphne intermedia (Elmer) Kosterm. ex Brambach & Pelser	2	1	0.01	16.67	2.53	2.50	2.52
Aglaia argentea Blume	1	1	0.01	16.67	1.27	2.50	1.88
Arcangelisia flava (L.) Merr.	1	1	0.01	16.67	1.27	2.50	1.88
Atalantia racemosa Wight & Arn.	1	1	0.01	16.67	1.27	2.50	1.88
Bridelia stipularis (L.) Blume	2	1	0.01	16.67	2.53	2.50	2.52
Ficus septica Burm.f.	1	1	0.01	16.67	1.27	2.50	1.88
Glochidion luzonense Elmer	1	1	0.01	16.67	1.27	2.50	1.88
Guioa koelreuteria (Blanco) Merr.	6	2	0.04	33.33	7.59	5.00	**6.30**
Lantana camara L.	9	4	0.06	66.67	11.39	10.00	**10.70**
Leea manillensis Walp.	11	5	0.07	83.33	13.92	12.50	**13.21**
Leptosolena haenkei C.Presl	15	5	0.10	83.33	18.99	12.50	**15.74**
Melicope triphylla (Lam.) Merr.	2	2	0.01	33.33	2.53	5.00	3.77
Miscanthus floridulus (Labill.) Warb. ex K.Schum. & Lauterb.	14	4	0.09	66.67	17.72	10.00	**13.86**
Pittosporum pentandrum (Blanco) Merr.	3	2	0.02	33.33	3.80	5.00	4.40
Premna serratifolia L.	1	1	0.01	16.67	1.27	2.50	1.88
Prunus fragrans (Elmer) Kalkman	1	1	0.01	16.67	1.27	2.50	1.88
Psidium guajava L.	1	1	0.01	16.67	1.27	2.50	1.88
Semecarpus cuneiformis Blanco	1	1	0.01	16.67	1.27	2.50	1.88
Symplocos cochinchinensis (Lour.) S.Moore	3	2	0.02	33.33	3.80	5.00	4.40
Viburnum luzonicum Rolfe	1	1	0.01	16.67	1.27	2.50	1.88
Wendlandia luzoniensis DC.	1	1	0.01	16.67	1.27	2.50	1.88
Ziziphus trinervis (Cav.) Poir.	1	1	0.01	16.67	1.27	2.50	1.88

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 2C Population Counts for Herbs in Forest Plot along Chico River in Alab, Bontoc as Upstream Station

Herbs	ni	Ji	Di	Fi	RDi	RFi	IV
Abrus precatorius L.	1	1	0.11	11.11	1.28	2.50	1.89
Adiantum hispidulum Sw.	3	1	0.33	11.11	3.85	2.50	3.17
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	8	2	0.89	22.22	10.26	5.00	**7.63**
Ageratina riparia (Regel) R.M.King & H.Rob.	21	6	2.33	66.67	26.92	15.00	**20.96**
Alyxia concatenata (Blanco) Merr.	2	2	0.22	22.22	2.56	5.00	3.78
Ampelopsis glandulosa (Wall.) Momiy.	2	1	0.22	11.11	2.56	2.50	2.53
Ardisia darlingii Merr.	3	2	0.33	22.22	3.85	5.00	4.42
Asplenium affine Sw.	1	1	0.11	11.11	1.28	2.50	1.89
Bridelia insulana Hance	1	1	0.11	11.11	1.28	2.50	1.89
Cardiospermum halicacabum L.	3	2	0.33	22.22	3.85	5.00	**4.42**
Chromolaena odorata (L.) R.M.King & H.Rob.	2	2	0.22	22.22	2.56	5.00	3.78
Elephantopus tomentosus L.	1	1	0.11	11.11	1.28	2.50	1.89
Erigeron sumatrensis Retz.	2	1	0.22	11.11	2.56	2.50	2.53
Glochidion luzonense Elmer	1	1	0.11	11.11	1.28	2.50	1.89
Gynura procumbens (Lour.) Merr.	1	1	0.11	11.11	1.28	2.50	1.89
Lantana camara L.	2	1	0.22	11.11	2.56	2.50	2.53
Mikania micrantha Kunth	3	3	0.33	33.33	3.85	7.50	**5.67**
Nephrolepis biserrata (Sw.) Schott	1	1	0.11	11.11	1.28	2.50	1.89
Pericampylus glaucus (Lam.) Merr.	1	1	0.11	11.11	1.28	2.50	1.89
Pyrrosia porosa (C.Presl) Hovenkamp	3	1	0.33	11.11	3.85	2.50	3.17
Rosa transmorrisonensis Hayata	3	2	0.33	22.22	3.85	5.00	4.42
Scleria lithosperma (L.) Sw	1	1	0.11	11.11	1.28	2.50	1.89
Stachytarpheta jamaicensis (L.) Vahl	2	1	0.22	11.11	2.56	2.50	2.53
Stephania japonica (Thunb.) Miers	1	1	0.11	11.11	1.28	2.50	1.89
Strobilanthes cumingiana (Nees) Y.F.Deng & J.R.I.Wood	1	1	0.11	11.11	1.28	2.50	1.89
Viburnum luzonicum Rolfe	1	1	0.11	11.11	1.28	2.50	1.89
Ziziphus trinervis (Cav.) Poir.	7	1	0.78	11.11	8.97	2.50	**5.74**

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 3 Population Counts for Herbs in Ricefield Plot along Chico River in Alab, Bontoc as Upstream Station

Herbs	ni	Ji	Di	Fi	RDi	RFi	IV
Acalypha amentacea Roxb.	2	1	0.22	11.11	1.89	1.75	1.82
Acalypha indica L.	1	1	0.11	11.11	0.94	1.75	1.35
Ageratum conyzoides L.	5	2	0.56	22.22	4.72	3.51	4.11
Alternanthera sessilis (L.) DC.	6	2	0.67	22.22	5.66	3.51	**4.58**
Amaranthus spinosus L.	2	1	0.22	11.11	1.89	1.75	1.82
Bidens pilosa L.	12	6	1.33	66.67	11.32	10.53	**10.92**
Cardiospermum halicacabum L.	6	2	0.67	22.22	5.66	3.51	**4.58**
Cenchrus echinatus L.	1	1	0.11	11.11	0.94	1.75	1.35
Commelina diffusa Burm.f.	2	1	0.22	11.11	1.89	1.75	1.82
Crassocephalum crepidioides (Benth.) S.Moore	4	2	0.44	22.22	3.77	3.51	3.64
Cuphea carthagenensis (Jacq.) J.F.Macbr.	1	1	0.11	11.11	0.94	1.75	1.35
Cynodon dactylon (L.) Pers.	3	1	0.33	11.11	2.83	1.75	2.29
Cyrtococcum patens (L.) A.Camus	2	1	0.22	11.11	1.89	1.75	1.82
Davallia repens (L.f.) Kuhn	2	1	0.22	11.11	1.89	1.75	1.82
Desmodium procumbens (Mill.) Hitchc.	1	1	0.11	11.11	0.94	1.75	1.35
Digitaria sanguinalis (L.) Scop.	1	1	0.11	11.11	0.94	1.75	1.35
Drynaria quercifolia (L.) J.Sm.	1	1	0.11	11.11	0.94	1.75	1.35
Eleusine indica (L.) Gaertn.	1	1	0.11	11.11	0.94	1.75	1.35
Equisetum ramosissimum Desf.	3	1	0.33	11.11	2.83	1.75	2.29
Erigeron sumatrensis Retz.	8	5	0.89	55.56	7.55	8.77	**8.16**
Euphorbia heterophylla L.	2	1	0.22	11.11	1.89	1.75	1.82
Euphorbia hirta L.	3	2	0.33	22.22	2.83	3.51	3.17
Ficus cumingii Miq.	1	1	0.11	11.11	0.94	1.75	1.35
Hibiscus sabdariffa L.	1	1	0.11	11.11	0.94	1.75	1.35
Hyptis brevipes Poit.	2	1	0.22	11.11	1.89	1.75	1.82
Ipomoea aquatica Forssk.	3	1	0.33	11.11	2.83	1.75	2.29
Ipomoea batatas (L.) Poir.	1	1	0.11	11.11	0.94	1.75	1.35
Ludwigia perennis L.	2	1	0.22	11.11	1.89	1.75	1.82
Melinis minutiflora P.Beauv.	1	1	0.11	11.11	0.94	1.75	1.35
Mimosa pudica L.	2	1	0.22	11.11	1.89	1.75	1.82
Oryza sativa L.	5	1	0.56	11.11	4.72	1.75	3.24
Persicaria chinensis (L.) H.Gross	1	1	0.11	11.11	0.94	1.75	1.35
Phragmites karka (Retz.) Trin. ex Steud.	1	1	0.11	11.11	0.94	1.75	1.35
Portulaca oleracea L.	2	1	0.22	11.11	1.89	1.75	1.82
Pseudelephantopus spicatus (Juss. ex Aubl.) Rohr	5	3	0.56	33.33	4.72	5.26	**4.99**
Ricinus communis L.	1	1	0.11	11.11	0.94	1.75	1.35
Solanum americanum Mill.	3	2	0.33	22.22	2.83	3.51	3.17
Tithonia diversifolia (Hemsl.) A.Gray	2	1	0.22	11.11	1.89	1.75	1.82
Tridax procumbens L.	2	1	0.22	11.11	1.89	1.75	1.82
Urochloa mutica (Forssk.) T.Q.Nguyen	2	1	0.22	11.11	1.89	1.75	1.82

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 4 Population Counts for Herbs in Residential Plot along Chico River in Alab, Bontoc as Upstream Station

Herbs	ni	Ji	Di	Fi	RDi	RFi	IV
Acalypha amentacea Roxb.	4	2	0.44	22.22	4.71	4.35	**4.53**
Adiantum philippense L.	2	1	0.22	11.11	2.35	2.17	2.26
Ageratina riparia (Regel) R.M.King & H.Rob.	8	3	0.89	33.33	9.41	6.52	**7.97**
Ageratum conyzoides L.	3	1	0.33	11.11	3.53	2.17	2.85
Amaranthus spinosus L.	1	1	0.11	11.11	1.18	2.17	1.68
Bambusa vulgaris Schrad. ex J.C.Wendl.	1	1	0.11	11.11	1.18	2.17	1.68
Bidens pilosa L.	1	1	0.11	11.11	1.18	2.17	1.68
Canna indica L.	3	1	0.33	11.11	3.53	2.17	2.85
Cenchrus purpureus (Schumach.) Morrone	2	1	0.22	11.11	2.35	2.17	2.26
Cyathula prostrata (L.) Blume	1	1	0.11	11.11	1.18	2.17	1.68
Cypholophus brunneolus Elmer	1	1	0.11	11.11	1.18	2.17	1.68
Dysphania ambrosioides (L.) Mosyakin & Clemants	1	1	0.11	11.11	1.18	2.17	1.68
Eleusine indica (L.) Gaertn.	3	1	0.33	11.11	3.53	2.17	2.85
Epipremnum pinnatum (L.) Engl.	1	1	0.11	11.11	1.18	2.17	1.68
Ficus septica Burm.f.	1	1	0.11	11.11	1.18	2.17	1.68
Ficus ulmifolia Lam.	1	1	0.11	11.11	1.18	2.17	1.68
Gomphrena globosa L.	2	1	0.22	11.11	2.35	2.17	2.26
Ipomoea aquatica Forssk.	4	1	0.44	11.11	4.71	2.17	3.44
Ipomoea batatas (L.) Poir.	8	3	0.89	33.33	9.41	6.52	**7.97**
Iresine diffusa Humb. & Bonpl. ex Willd.	1	1	0.11	11.11	1.18	2.17	1.68
Kalanchoe pinnata (Lam.) Pers.	1	1	0.11	11.11	1.18	2.17	1.68
Lantana camara L.	3	3	0.33	33.33	3.53	6.52	**5.03**
Mangifera indica L.	1	1	0.11	11.11	1.18	2.17	1.68
Melothria pendula L.	2	1	0.22	11.11	2.35	2.17	2.26
Mikania micrantha Kunth	5	1	0.56	11.11	5.88	2.17	**4.03**
Musa × *paradisiaca* L.	1	1	0.11	11.11	1.18	2.17	1.68
Oxalis corniculata L.	1	1	0.11	11.11	1.18	2.17	1.68
Paspalum conjugatum P.J.Bergius	2	1	0.22	11.11	2.35	2.17	2.26
Piper betle L.	2	1	0.22	11.11	2.35	2.17	2.26
Rhynchospora colorata (L.) H.Pfeiff.	1	1	0.11	11.11	1.18	2.17	1.68
Sechium edule (Jacq.) Sw.	3	1	0.33	11.11	3.53	2.17	2.85
Setaria palmifolia (J.Koenig) Stapf	3	2	0.33	22.22	3.53	4.35	3.94
Solanum americanum Mill.	1	1	0.11	11.11	1.18	2.17	1.68
Solanum lycopersicum L.	3	1	0.33	11.11	3.53	2.17	2.85
Sporobolus indicus (L.) R.Br.	1	1	0.11	11.11	1.18	2.17	1.68
Talinum fruticosum (L.) Juss.	1	1	0.11	11.11	1.18	2.17	1.68
Tithonia diversifolia (Hemsl.) A.Gray	3	1	0.33	11.11	3.53	2.17	2.85
Xanthosoma sagittifolium (L.) Schott	2	1	0.22	11.11	2.35	2.17	2.26

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 5A Population Counts for Trees in Forest Plot along Chico River in Lanao, Bontoc as Midstream Station

Trees	CCH	ni	DBH	Di	Ji	BAi	RDi	RFi	RBAi	IV
Ficus nota (Blanco) Merr.	21	1	6.68	0.0008	33.33	0.24	4.76	6.67	0.30	3.91
Macaranga tanarius (L.) Müll.Arg.	68	2	21.65	0.0017	66.67	2.56	9.52	13.33	3.19	**8.68**
Mangifera indica L.	76	1	24.19	0.0008	33.33	3.19	4.76	6.67	3.98	5.14
Meliosma pinnata (Roxb.) Maxim.	36	1	11.46	0.0008	33.33	0.72	4.76	6.67	0.89	4.11
Pinus kesiya Royle ex Gordon	209	2	66.53	0.0017	33.33	24.14	9.52	6.67	30.10	**15.43**
Pittosporum pentandrum (Blanco) Merr.	125	2	39.79	0.0017	33.33	8.63	9.52	6.67	10.77	**8.99**
Premna serratifolia L.	52	1	16.55	0.0008	33.33	1.49	4.76	6.67	1.86	4.43
Prunus fragrans (Elmer) Kalkman	147	4	46.79	0.0033	66.67	11.94	19.05	13.33	14.89	**15.76**
Syzygium nitidum Benth.	17	1	5.41	0.0008	33.33	0.16	4.76	6.67	0.20	3.88
Vaccinium cumingianum S.Vidal	213.5	5	67.96	0.0042	100.00	25.19	23.81	20.00	31.41	**25.07**
Wendlandia luzoniensis DC.	59	1	18.78	0.0008	33.33	1.92	4.76	6.67	2.40	4.61

Note: CCH – circumference of chest height; ni – number of individual of species; Ji – number of plot where the species occur; DBH - diameter at breast height; Di – density of species; Fi – frequency of species; BAi – basal area of species; RDi – relative density of species; RFi – relative frequency of species; RBAi – relative basal area of species; IV – importance value

Table no. 5B Population Counts for Shrubs in Forest Plot along Chico River in Lanao, Bontoc as Midstream Station

Shrubs	ni	Ji	Di	Fi	RDi	RFi	IV
Acalypha amentacea Roxb.	2	2	0.01	33.33	2.63	4.35	3.49
Actinodaphne intermedia (Elmer) Kosterm. ex Brambach & Pelser	2	2	0.01	33.33	2.63	4.35	3.49
Ardisia darlingii Merr.	2	1	0.01	16.67	2.63	2.17	2.40
Atalantia racemosa Wight & Arn.	4	2	0.03	33.33	5.26	4.35	4.81
Bridelia insulana Hance	3	1	0.02	16.67	3.95	2.17	3.06
Cenchrus purpureus (Schumach.) Morrone	1	1	0.01	16.67	1.32	2.17	1.74
Commersonia bartramia (L.) Merr.	1	1	0.01	16.67	1.32	2.17	1.74
Eurya chinensis R.Br.	5	4	0.03	66.67	6.58	8.70	**7.64**
Flemingia macrophylla (Willd.) Kuntze ex Prain	2	1	0.01	16.67	2.63	2.17	2.40
Guioa koelreuteria (Blanco) Merr.	1	1	0.01	16.67	1.32	2.17	1.74
Lantana camara L.	2	1	0.01	16.67	2.63	2.17	2.40
Leea manillensis Walp.	5	2	0.03	33.33	6.58	4.35	**5.46**
Leptosolena haenkei C.Presl	4	3	0.03	50.00	5.26	6.52	**5.89**
Leucosyke benguetensis Unruh	5	3	0.03	50.00	6.58	6.52	6.55
Mallotus mollissimus (Geiseler) Airy Shaw	1	1	0.01	16.67	1.32	2.17	1.74
Miscanthus floridulus (Labill.) Warb. ex K.Schum. & Lauterb.	15	6	0.10	100.00	19.74	13.04	**16.39**
Mnesithea rottboellioides (R.Br.) de Koning & Sosef	1	1	0.01	16.67	1.32	2.17	1.74
Pittosporum pentandrum (Blanco) Merr.	1	1	0.01	16.67	1.32	2.17	1.74
Premna serratifolia L.	1	1	0.01	16.67	1.32	2.17	1.74
Prunus fragrans (Elmer) Kalkman	8	4	0.05	66.67	10.53	8.70	**9.61**
Syzygium nitidum Benth.	3	2	0.02	33.33	3.95	4.35	4.15
Turpinia ovalifolia Elmer	4	2	0.03	33.33	5.26	4.35	4.81
Viburnum luzonicum Rolfe	2	2	0.01	33.33	2.63	4.35	3.49
Wendlandia luzoniensis DC.	1	1	0.01	16.67	1.32	2.17	1.74

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 5C Population Counts for Herbs in Forest Plot along Chico River in Lanao, Bontoc as Midstream Station

Herbs	ni	Ji	Di	Fi	RDi	RFi	IV
Ageratina riparia (Regel) R.M.King & H.Rob.	20	4	2.22	44.44	18.69	7.69	**13.19**
Bidens pilosa L.	1	1	0.11	11.11	0.93	1.92	1.43
Bridelia insulana Hance	2	1	0.22	11.11	1.87	1.92	1.90
Chromolaena odorata (L.) R.M.King & H.Rob.	5	3	0.56	33.33	4.67	5.77	5.22
Davallia repens (L.f.) Kuhn	2	1	0.22	11.11	1.87	1.92	1.90
Dennstaedtia scandens (Blume) T.Moore	1	1	0.11	11.11	0.93	1.92	1.43
Desmodium procumbens (Mill.) Hitchc.	1	1	0.11	11.11	0.93	1.92	1.43
Dianella javanica (Blume) Kunth	5	2	0.56	22.22	4.67	3.85	4.26
Drynaria speciosa (Blume) Christenh.	23	7	2.56	77.78	21.50	13.46	**17.48**
Elephantopus tomentosus L.	7	4	0.78	44.44	6.54	7.69	**7.12**
Flemingia macrophylla (Willd.) Kuntze ex Prain	1	1	0.11	11.11	0.93	1.92	1.43
Goniophlebium benguetense (Copel.) Copel.	2	2	0.22	22.22	1.87	3.85	2.86
Helicia robusta (Roxb.) R.Br. ex Blume	1	1	0.11	11.11	0.93	1.92	1.43
Lantana camara L.	1	1	0.11	11.11	0.93	1.92	1.43
Leucosyke capitellata Wedd.	1	1	0.11	11.11	0.93	1.92	1.43
Lygodium flexuosum (L.) Sw.	5	4	0.56	44.44	4.67	7.69	**6.18**
Medinilla lagunae S.Vidal	2	1	0.22	11.11	1.87	1.92	1.90
Melastoma malabathricum L.	2	1	0.22	11.11	1.87	1.92	1.90
Microsorum punctatum (L.) Copel.	2	1	0.22	11.11	1.87	1.92	1.90
Nephrolepis biserrata (Sw.) Schott	11	4	1.22	44.44	10.28	7.69	**8.99**
Oplismenus hirtellus (L.) P.Beauv.	1	1	0.11	11.11	0.93	1.92	1.43
Pogonatherum crinitum (Thunb.) Kunth	1	1	0.11	11.11	0.93	1.92	1.43
Psychotria gitingensis Elmer	1	1	0.11	11.11	0.93	1.92	1.43
Pteridium aquilinum (L.) Kuhn	1	1	0.11	11.11	0.93	1.92	1.43
Saccharum spontaneum L.	2	1	0.22	11.11	1.87	1.92	1.90
Scleria lithosperma (L.) Sw	3	2	0.33	22.22	2.80	3.85	3.32
Setaria palmifolia (J.Koenig) Stapf	1	1	0.11	11.11	0.93	1.92	1.43
Tetrastigma loheri Gagnep.	1	1	0.11	11.11	0.93	1.92	1.43
Viburnum luzonicum Rolfe	1	1	0.11	11.11	0.93	1.92	1.43

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 6 Population Counts for Herbs in Ricefield Plot along Chico River in Lanao, Bontoc as Midstream Station

Herbs	ni	Ji	Di	Fi	RDi	RFi	IV
Acalypha amentacea Roxb.	1	1	0.11	11.11	0.85	1.89	1.37
Acmella grandiflora (Turcz.) R.K.Jansen	2	1	0.22	11.11	1.71	1.89	1.80
Ageratina riparia (Regel) R.M.King & H.Rob.	4	2	0.44	22.22	3.42	3.77	3.60
Ageratum conyzoides L.	21	6	2.33	66.67	17.95	11.32	**14.63**
Alternanthera philoxeroides (Mart.) Griseb.	2	1	0.22	11.11	1.71	1.89	1.80
Apluda mutica L.	2	1	0.22	11.11	1.71	1.89	1.80
Arivela viscosa (L.) Raf.	1	1	0.11	11.11	0.85	1.89	1.37
Bidens pilosa L.	10	5	1.11	55.56	8.55	9.43	**8.99**
Canscora diffusa (Vahl) R.Br. ex Roem. & Schult.	2	1	0.22	11.11	1.71	1.89	1.80
Cenchrus purpureus (Schumach.) Morrone	5	1	0.56	11.11	4.27	1.89	3.08
Centella asiatica (L.) Urb.	2	1	0.22	11.11	1.71	1.89	1.80
Chromolaena odorata (L.) R.M.King & H.Rob.	1	1	0.11	11.11	0.85	1.89	1.37
Crassocephalum crepidioides (Benth.) S.Moore	2	1	0.22	11.11	1.71	1.89	1.80
Cuphea carthagenensis (Jacq.) J.F.Macbr.	2	1	0.22	11.11	1.71	1.89	1.80
Cyperus javanicus Houtt.	1	1	0.11	11.11	0.85	1.89	1.37
Cyrtococcum patens (L.) A.Camus	1	1	0.11	11.11	0.85	1.89	1.37
Davallia repens (L.f.) Kuhn	5	2	0.56	22.22	4.27	3.77	4.02
Digitaria sanguinalis (L.) Scop.	4	1	0.44	11.11	3.42	1.89	2.65
Diplazium esculentum (Retz.) Sw.	5	3	0.56	33.33	4.27	5.66	**4.97**
Drymaria cordata (L.) Willd. ex Roem. & Schult.	1	1	0.11	11.11	0.85	1.89	1.37
Drynaria speciosa (Blume) Christenh.	2	1	0.22	11.11	1.71	1.89	1.80
Echinochloa stagnina (Retz.) P.Beauv.	1	1	0.11	11.11	0.85	1.89	1.37
Eleusine indica (L.) Gaertn.	2	1	0.22	11.11	1.71	1.89	1.80
Equisetum ramosissimum Desf.	10	2	1.11	22.22	8.55	3.77	**6.16**
Erigeron sumatrensis Retz.	4	2	0.44	22.22	3.42	3.77	3.60
Euphorbia hirta L.	2	1	0.22	11.11	1.71	1.89	1.80
Ficus cumingii Miq.	1	1	0.11	11.11	0.85	1.89	1.37
Hoya cumingiana Decne.	2	1	0.22	11.11	1.71	1.89	1.80
Laphangium luteoalbum (L.) Tzvelev	2	1	0.22	11.11	1.71	1.89	1.80
Melinis minutiflora P.Beauv.	2	1	0.22	11.11	1.71	1.89	1.80
Phragmites karka (Retz.) Trin. ex Steud.	1	1	0.11	11.11	0.85	1.89	1.37
Pogonatherum crinitum (Thunb.) Kunth	6	2	0.67	22.22	5.13	3.77	**4.45**
Pseudelephantopus spicatus (Juss. ex Aubl.) Rohr	2	1	0.22	11.11	1.71	1.89	1.80
Psidium guajava L.	1	1	0.11	11.11	0.85	1.89	1.37
Pyrrosia porosa (C.Presl) Hovenkamp	3	1	0.33	11.11	2.56	1.89	2.23
Solanum americanum Mill.	1	1	0.11	11.11	0.85	1.89	1.37
Sonchus wightianus DC.	1	1	0.11	11.11	0.85	1.89	1.37

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 7 Population Counts for Herbs in Residential Plot along Chico River in Lanao, Bontoc as Midstream Station

Herbs	ni	Ji	Di	Fi	RDi	RFi	IV
Acalypha amentacea Roxb.	5	2	0.56	22.22	5.81	6.67	**6.24**
Acalypha indica L.	1	1	0.11	11.11	1.16	3.33	2.25
Ageratum conyzoides L.	1	1	0.11	11.11	1.16	3.33	2.25
Amaranthus viridis L.	1	1	0.11	11.11	1.16	3.33	2.25
Bidens pilosa L.	2	1	0.22	11.11	2.33	3.33	2.83
Cenchrus purpureus (Schumach.) Morrone	3	1	0.33	11.11	3.49	3.33	3.41
Chloranthus officinalis Blume	2	1	0.22	11.11	2.33	3.33	2.83
Chromolaena odorata (L.) R.M.King & H.Rob.	3	1	0.33	11.11	3.49	3.33	3.41
Coix lacryma-jobi L.	1	1	0.11	11.11	1.16	3.33	2.25
Cynodon dactylon (L.) Pers.	15	2	1.67	22.22	17.44	6.67	**12.05**
Cyperus alternifolius L.	2	1	0.22	11.11	2.33	3.33	2.83
Dysphania ambrosioides (L.) Mosyakin & Clemants	1	1	0.11	11.11	1.16	3.33	2.25
Lantana camara L.	2	1	0.22	11.11	2.33	3.33	2.83
Melia azedarach L.	5	1	0.56	11.11	5.81	3.33	4.57
Melinis minutiflora P.Beauv.	4	2	0.44	22.22	4.65	6.67	**5.66**
Mikania micrantha Kunth	2	2	0.22	22.22	2.33	6.67	4.50
Passiflora foetida L.	3	1	0.33	11.11	3.49	3.33	3.41
Phaseolus lunatus L.	2	1	0.22	11.11	2.33	3.33	2.83
Pilea microphylla (L.) Liebm.	2	1	0.22	11.11	2.33	3.33	2.83
Pontederia crassipes Mart.	15	2	1.67	22.22	17.44	6.67	**12.05**
Pteris vittata L. ex Hieron.	1	1	0.11	11.11	1.16	3.33	2.25
Solanum lycopersicum L.	1	1	0.11	11.11	1.16	3.33	2.25
Tithonia diversifolia (Hemsl.) A.Gray	7	2	0.78	22.22	8.14	6.67	**7.40**
Tridax procumbens L.	5	1	0.56	11.11	5.81	3.33	4.57

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 8A Population Counts for Trees in Forest Plots along Chico River in Tocucan, Bontoc as Downstream Station

Trees	CCH	ni	Ji	DBH	BAi	Di	Fi	RBAi	RDi	RFi	IV
Atalantia racemosa Wight & Arn.	42.5	1	1	13.53	1.00	0.0008	33.33	0.27	2.17	3.85	2.10
Bridelia insulana Hance	164.5	4	3	52.36	14.95	0.0033	100.00	4.07	8.70	11.54	**8.10**
Cinnamomum iners Reinw. ex Blume	267	1	2	84.99	39.39	0.0008	66.67	10.73	2.17	7.69	6.86
Commersonia bartramia (L.) Merr.	142	1	1	45.20	11.14	0.0008	33.33	3.03	2.17	3.85	3.02
Deutzia pulchra S.Vidal	19	1	1	6.05	0.20	0.0008	33.33	0.05	2.17	3.85	2.02
Engelhardia spicata Lesch. ex Blume	57	1	1	18.14	1.80	0.0008	33.33	0.49	2.17	3.85	2.17
Ficus ampelas Burm.f.	290	7	1	92.31	46.47	0.0058	33.33	12.65	15.22	3.85	**10.57**
Ficus balete Merr.	514	5	2	163.61	146.00	0.0042	66.67	39.76	10.87	7.69	**19.44**
Ficus nota (Blanco) Merr.	118	3	2	37.56	7.69	0.0025	66.67	2.10	6.52	7.69	5.44
Ficus pseudopalma Blanco	64	1	1	20.37	2.26	0.0008	33.33	0.62	2.17	3.85	2.21
Kanapia monstrosa (A.Rich.) Arriola & Alejandro	119	2	1	37.88	7.83	0.0017	33.33	2.13	4.35	3.85	3.44
Leea manillensis Walp.	39	1	1	12.41	0.84	0.0008	33.33	0.23	2.17	3.85	2.08
Mallotus mollissimus (Geiseler) Airy Shaw	84	1	1	26.74	3.90	0.0008	33.33	1.06	2.17	3.85	2.36
Neonauclea reticulata (Havil.) Merr.	85	1	1	27.06	3.99	0.0008	33.33	1.09	2.17	3.85	2.37
Pittosporum pentandrum (Blanco) Merr.	20	1	1	6.37	0.22	0.0008	33.33	0.06	2.17	3.85	2.03
Saurauia bontocensis Merr.	32	1	1	10.19	0.57	0.0008	33.33	0.15	2.17	3.85	2.06
Semecarpus cuneiformis Blanco	53	1	1	16.87	1.55	0.0008	33.33	0.42	2.17	3.85	2.15
Turpinia ovalifolia Elmer	241.5	6	2	76.87	32.23	0.0050	66.67	8.78	13.04	7.69	**9.84**
Wendlandia luzoniensis DC.	286	7	2	91.04	45.20	0.0058	66.67	12.31	15.22	7.69	**11.74**

Note: CCH – circumference of chest height; ni – number of individual of species; Ji – number of plot where the species occur; DBH - diameter at breast height; BAi – basal area of species; Di – density of species; Fi – frequency of species; RBAi – relative basal area of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 8B Population Counts for Shrubs in Forest Plots along Chico River in Tocucan, Bontoc as Downstream Station

Shrub	ni	Ji	Di	Fi	RDi	RFi	IV
Acalypha amentacea Roxb.	5	2	0.03	33.33	8.06	4.76	**6.41**
Aglaia argentea Blume	1	1	0.01	16.67	1.61	2.38	2.00
Antidesma microcarpum Elmer	1	1	0.01	16.67	1.61	2.38	2.00
Ardisia darlingii Merr.	1	1	0.01	16.67	1.61	2.38	2.00
Bridelia insulana Hance	2	2	0.01	33.33	3.23	4.76	3.99
Deutzia pulchra S.Vidal	5	3	0.03	50.00	8.06	7.14	**7.60**
Dodonaea viscosa (L.) Jacq.	4	2	0.03	33.33	6.45	4.76	5.61
Ficus nervosa B.Heyne ex Roth	1	1	0.01	16.67	1.61	2.38	2.00
Ficus pseudopalma Blanco	1	1	0.01	16.67	1.61	2.38	2.00
Flacourtia indica (Burm.f.) Merr.	1	1	0.01	16.67	1.61	2.38	2.00
Flemingia macrophylla (Willd.) Kuntze ex Prain	1	1	0.01	16.67	1.61	2.38	2.00
Guioa koelreuteria (Blanco) Merr.	1	1	0.01	16.67	1.61	2.38	2.00
Leea manillensis Walp.	3	3	0.02	50.00	4.84	7.14	**5.99**
Leptosolena haenkei C.Presl	4	2	0.03	33.33	6.45	4.76	5.61
Leucaena leucocephala (Lam.) de Wit	3	1	0.02	16.67	4.84	2.38	3.61
Leucosyke benguetensis Unruh	3	2	0.02	33.33	4.84	4.76	4.80
Medinilla lagunae S.Vidal	2	2	0.01	33.33	3.23	4.76	3.99
Miscanthus floridulus (Labill.) Warb. ex K.Schum. & Lauterb.	6	3	0.04	50.00	9.68	7.14	**8.41**
Pittosporum pentandrum (Blanco) Merr.	1	1	0.01	16.67	1.61	2.38	2.00
Prunus arborea (Blume) Kalkman	3	3	0.02	50.00	4.84	7.14	5.99
Semecarpus cuneiformis Blanco	3	2	0.02	33.33	4.84	4.76	4.80
Thysanolaena latifolia (Roxb. ex Hornem.) Honda	2	1	0.01	16.67	3.23	2.38	2.80
Turpinia ovalifolia Elmer	5	3	0.03	50.00	8.06	7.14	**7.60**
Vanoverberghia vanoverberghii (Merr.) Funak. & Docot	2	1	0.01	16.67	3.23	2.38	2.80
Ziziphus trinervis (Cav.) Poir.	1	1	0.01	16.67	1.61	2.38	2.00

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 8C Population Counts for Herbs in Forest Plots along Chico River in Tocucan, Bontoc as Downstream Station

Herbs	ni	Ji	Di	Fi	RDi	RFi	IV
Abrus precatorius L.	2	1	0.22	11.11	1.71	1.96	1.84
Acalypha amentacea Roxb.	2	1	0.22	11.11	1.71	1.96	1.84
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	6	3	0.67	33.33	5.13	5.88	**5.51**
Ageratina riparia (Regel) R.M.King & H.Rob.	49	7	5.44	77.78	41.88	13.73	**27.80**
Ampelopsis glandulosa (Wall.) Momiy.	1	1	0.11	11.11	0.85	1.96	1.41
Chamaecrista mimosoides (L.) Greene	1	1	0.11	11.11	0.85	1.96	1.41
Chromolaena odorata (L.) R.M.King & H.Rob.	3	2	0.33	22.22	2.56	3.92	3.24
Commelina diffusa Burm.f.	2	1	0.22	11.11	1.71	1.96	1.84
Cynanchum ovalifolium Wight	2	1	0.22	11.11	1.71	1.96	1.84
Davallia embolostegia Copel.	1	1	0.11	11.11	0.85	1.96	1.41
Davallia repens (L.f.) Kuhn	1	1	0.11	11.11	0.85	1.96	1.41
Desmodium procumbens (Mill.) Hitchc.	3	1	0.33	11.11	2.56	1.96	2.26
Diplazium esculentum (Retz.) Sw.	1	1	0.11	11.11	0.85	1.96	1.41
Drynaria quercifolia (L.) J.Sm.	6	3	0.67	33.33	5.13	5.88	**5.51**
Equisetum ramosissimum Desf.	1	1	0.11	11.11	0.85	1.96	1.41
Goniophlebium benguetense (Copel.) Copel.	1	1	0.11	11.11	0.85	1.96	1.41
Hylodesmum repandum (Vahl) H.Ohashi & R.R.Mill	2	2	0.22	22.22	1.71	3.92	2.82
Ipomoea binectarifera (Wall.) J.R.I.Wood & Scotland	2	2	0.22	22.22	1.71	3.92	2.82
Lygodium flexuosum (L.) Sw.	2	1	0.22	11.11	1.71	1.96	1.84
Mikania micrantha Kunth	3	2	0.33	22.22	2.56	3.92	3.24
Nephrolepis biserrata (Sw.) Schott	1	1	0.11	11.11	0.85	1.96	1.41
Oplismenus hirtellus (L.) P.Beauv.	4	1	0.44	11.11	3.42	1.96	2.69
Persea americana Mill.	1	1	0.11	11.11	0.85	1.96	1.41
Pouzolzia hirta (Blume) Hassk.	2	1	0.22	11.11	1.71	1.96	1.84
Pteris whitfordii Copel.	1	1	0.11	11.11	0.85	1.96	1.41
Reholttumia nitidula (C.Presl) S.E.Fawc. & A.R.Sm.	2	1	0.22	11.11	1.71	1.96	1.84
Rosa transmorrisonensis Hayata	2	1	0.22	11.11	1.71	1.96	1.84
Scleria lithosperma (L.) Sw	4	3	0.44	33.33	3.42	5.88	**4.65**
Selliguea taeniata (Sw.) Parris	1	1	0.11	11.11	0.85	1.96	1.41
Stachytarpheta jamaicensis (L.) Vahl	4	2	0.44	22.22	3.42	3.92	**3.67**
Syzygium nitidum Benth.	1	1	0.11	11.11	0.85	1.96	1.41
Tetrastigma loheri Gagnep.	1	1	0.11	11.11	0.85	1.96	1.41
Woodwardia unigemmata (Makino) Nakai	1	1	0.11	11.11	0.85	1.96	1.41
Ziziphus trinervis (Cav.) Poir.	1	1	0.11	11.11	0.85	1.96	1.41

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 9 Population Counts for Herbs in Ricefield Plots along Chico River in Tocucan, Bontoc as Downstream Station

Herbs	ni	Ji	Di	Fi	RDi	RFi	IV
Acalypha amentacea Roxb.	2	1	0.22	11.11	1.87	2.04	1.95
Ageratum conyzoides L.	6	2	0.67	22.22	5.61	4.08	**4.84**
Alternanthera sessilis (L.) DC.	1	1	0.11	11.11	0.93	2.04	1.49
Apluda mutica L.	3	2	0.33	22.22	2.80	4.08	3.44
Arivela viscosa (L.) Raf.	2	1	0.22	11.11	1.87	2.04	1.95
Bidens pilosa L.	10	3	1.11	33.33	9.35	6.12	**7.73**
Canscora diffusa (Vahl) R.Br. ex Roem. & Schult.	2	1	0.22	11.11	1.87	2.04	1.95
Chromolaena odorata (L.) R.M.King & H.Rob.	5	3	0.56	33.33	4.67	6.12	**5.40**
Cuphea carthagenensis (Jacq.) J.F.Macbr.	3	1	0.33	11.11	2.80	2.04	2.42
Davallia repens (L.f.) Kuhn	2	1	0.22	11.11	1.87	2.04	1.95
Diplazium esculentum (Retz.) Sw.	4	2	0.44	22.22	3.74	4.08	**3.91**
Eleusine indica (L.) Gaertn.	1	1	0.11	11.11	0.93	2.04	1.49
Erigeron sumatrensis Retz.	3	2	0.33	22.22	2.80	4.08	3.44
Euphorbia hirta L.	4	2	0.44	22.22	3.74	4.08	**3.91**
Ficus ulmifolia Lam.	2	1	0.22	11.11	1.87	2.04	1.95
Hyptis brevipes Poit.	3	1	0.33	11.11	2.80	2.04	2.42
Imperata cylindrica (L.) P.Beauv.	4	1	0.44	11.11	3.74	2.04	2.89
Ipomoea batatas (L.) Poir.	3	2	0.33	22.22	2.80	4.08	3.44
Lantana camara L.	1	1	0.11	11.11	0.93	2.04	1.49
Lygodium flexuosum (L.) Sw.	4	2	0.44	22.22	3.74	4.08	3.91
Melinis minutiflora P.Beauv.	2	1	0.22	11.11	1.87	2.04	1.95
Mimosa pudica L.	2	2	0.22	22.22	1.87	4.08	2.98
Nephrolepis biserrata (Sw.) Schott	2	1	0.22	11.11	1.87	2.04	1.95
Paspalum scrobiculatum L.	1	1	0.11	11.11	0.93	2.04	1.49
Passiflora foetida L.	2	1	0.22	11.11	1.87	2.04	1.95
Phragmites karka (Retz.) Trin. ex Steud.	3	1	0.33	11.11	2.80	2.04	2.42
Pogonatherum crinitum (Thunb.) Kunth	9	3	1.00	33.33	8.41	6.12	**7.27**
Pseudelephantopus spicatus (Juss. ex Aubl.) Rohr	3	1	0.33	11.11	2.80	2.04	2.42
Psidium guajava L.	2	1	0.22	11.11	1.87	2.04	1.95
Pteris vittata L. ex Hieron.	2	1	0.22	11.11	1.87	2.04	1.95
Rosa transmorrisonensis Hayata	3	1	0.33	11.11	2.80	2.04	2.42
Saccharum spontaneum L.	5	1	0.56	11.11	4.67	2.04	3.36
Stachytarpheta jamaicensis (L.) Vahl	4	2	0.44	22.22	3.74	4.08	**3.91**
Tithonia diversifolia (Hemsl.) A.Gray	2	1	0.22	11.11	1.87	2.04	1.95

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 10 Population Counts for Herbs in Residential Plots along Chico River in Tocucan, Bontoc as Downstream Station

Herbs	ni	Ji	Di	Fi	RDi	RFi	IV
Cardiospermum halicacabum L.	6	2	0.67	22.22	7.89	5.71	**6.80**
Cassia fistula L.	2	1	0.22	11.11	2.63	2.86	2.74
Centratherum punctatum Cass.	12	4	1.33	44.44	15.79	11.43	**13.61**
Chromolaena odorata (L.) R.M.King & H.Rob.	1	1	0.11	11.11	1.32	2.86	2.09
Cynodon dactylon (L.) Pers.	6	2	0.67	22.22	7.89	5.71	**6.80**
Davallia denticulata (Burm.f.) Mett. ex Kuhn	3	1	0.33	11.11	3.95	2.86	3.40
Davallia repens (L.f.) Kuhn	1	1	0.11	11.11	1.32	2.86	2.09
Dracaena fragrans (L.) Ker Gawl.	4	2	0.44	22.22	5.26	5.71	5.49
Drynaria quercifolia (L.) J.Sm.	1	1	0.11	11.11	1.32	2.86	2.09
Elephantopus tomentosus L.	3	1	0.33	11.11	3.95	2.86	3.40
Imperata cylindrica (L.) P.Beauv.	3	1	0.33	11.11	3.95	2.86	3.40
Lantana camara L.	1	1	0.11	11.11	1.32	2.86	2.09
Leucaena leucocephala (Lam.) de Wit	2	2	0.22	22.22	2.63	5.71	4.17
Leucosyke benguetensis Unruh	1	1	0.11	11.11	1.32	2.86	2.09
Mikania micrantha Kunth	7	2	0.78	22.22	9.21	5.71	**7.46**
Mimosa pudica L.	3	1	0.33	11.11	3.95	2.86	3.40
Nephrolepis biserrata (Sw.) Schott	2	1	0.22	11.11	2.63	2.86	2.74
Nicotiana tabacum L.	2	1	0.22	11.11	2.63	2.86	2.74
Passiflora foetida L.	1	1	0.11	11.11	1.32	2.86	2.09
Psidium guajava L.	2	1	0.22	11.11	2.63	2.86	2.74
Pteris whitfordii Copel.	1	1	0.11	11.11	1.32	2.86	2.09
Solanum diphyllum L.	1	1	0.11	11.11	1.32	2.86	2.09
Stachytarpheta jamaicensis (L.) Vahl	2	1	0.22	11.11	2.63	2.86	2.74
Tithonia diversifolia (Hemsl.) A.Gray	9	4	1.00	44.44	11.84	11.43	**11.64**

Note: ni – number of individual of species; Ji – number of plot where the species occur; Di – density of species; Fi – frequency of species; RDi – relative density of species; RFi – relative frequency of species; IV – importance value

Table no. 11 Jaccard index of similarity between sampling stations along Chico River

Sampling Stations		Upstream			Midstream			Downstream	
		Forest	Ricefield	Residential	Forest	Ricefield	Residential	Forest	Ricefield
Upstream	Ricefield	0.01	-	-	-	-	-	-	-
	Residential	0.03	0.11	-	-	-	-	-	-
Midstream	Forest	0.17	0.04	0.05	-	-	-	-	-
	Ricefield	0.04	0.18	0.09	0.08	-	-	-	-
	Residential	0.04	0.12	0.13	0.05	0.09	-	-	-
Downstream	Forest	0.15	0.04	0.03	0.17	0.05	0.03	-	-
	Ricefield	0.06	0.19	0.10	0.07	0.20	0.13	0.06	-
	Residential	0.08	0.07	0.05	0.07	0.03	0.11	0.07	0.15