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Research Article

Status and Diversity of Terrestrial plants in Ghodaghodi Lake Complex, Nepal

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Abstract

Among the Ramsar sites of Nepal, Ghodaghodi Lake Complex (GLC) is a biodiversity hotspot. This study was carried out to assess the status and diversity of terrestrial plants in GLC. Employing purposive sampling, altogether 38 plots were taken along the right-hand side of the foot trails around the GLC. Collected data were analyzed using formulas and Important Value Index (IVI) was calculated. A total of 50 terrestrial species from 27 families were recorded, among which 35 were trees, 8 shrubs, and 7 herbs. *Terminalia tomentosa* (Saj) has highest IVI (46.53) among tree species. Similarly, *Aerva lanata* (Khari) has highest IVI (54.13) among herb species and *Calotropis gigantea* (Aank) has highest IVI (68.56) among the shrub species. The Fabaceae family (n=7) represented the maximum numbers of plants species followed by Moraceae family.

Keywords: Biodiversity; Density; Fabaceae; Frequency; Terminalia tomentosa; Quadrants.

Introduction

It is well known that the development of human societies including human activities have effects on earth's system and can threaten the resilience of these. Globally, ecological processes are believed to be depending on plant diversity (Hooper and Vitousek, 1997; Tilman and Lehman, 1997; Quijas *et al*., 2010). Among the Asian countries, Nepal is placed on 9th position for its floral wealth (Bhattarai *et al*., 2011). Wetlands are the land that is covered by the shallow water and acts as transition zone between aquatic and terrestrial ecosystem. The water table is usually at or near the land surface (Mitsch and Gossenlink, 1986). Wetlands provides habitat for about 20% of the world's species although it covers only 4 to 6% of the earth's surface (Dugan, 1993). They actively influence on whole biomass production of water bodies by guiding the minerals and organic maters cycling; and also act as indicator of damage in the ecosystem (Niroula and Singh, 2011).

Plants play important role in livelihood of Nepalese people (Sharma *et al*., 2004) and they are used for different purposes in different locality of the country (Bhattarai *et al*., 2006; Kunwar and Bussmann, 2008). Plant diversity is

important for community stability, ecological services and ecosystem productivity which are valuable to human beings as well as economic development (Ruiz-Benito *et al*., 2014). Biodiversity loss and its protection have become a highlighting or challenging issue and emerging agenda all over the world since a few decades (Romport *et al*., 2008).

Wetlands plants play important role in socio-economy and culture by serving as wild food, medicine, fodder, fuel wood, handicrafts, thatching etc (Niroula and Singh, 2011). However, Wetland biodiversity is in threat due to unsustainable wetland resources exploitation, invasive alien species, and encroachment for agriculture land, drainage, diversion and abstraction of water for irrigation (MoFE, 2018). Change in the water quality or composition affect the diversity and distribution of wetland flora (Sonal *et al*., 2010). Plant diversity assessment is the first step ahead before the next step of conservation of these biological resources. But, very few researches regarding floral diversity of Ghodaghodi Lake Complex (GLC) have been done in the past. Therefore, this study might be helpful for developing the biodiversity profile of important terrestrial floral species at the Ghodaghodi Lake in Kailali district.

The objective of this study is to assess the terrestrial floral diversity and important value index of the plant species around the Ghodaghodi Lake Complex.

Materials and Methods

Study Area

The study was conducted during February, 2019 in the Ghodaghodi Lake Complex (28°41'N latitude and 80°56'E longitude with an altitude of 205m) which is a wetlands system situated in Kailali district, Sudurpachim Province of Nepal. It covers an area of 248 hectares including a cluster of nine lakes (Lamsal *et al*., 2015). It was included in a Ramsar site in 2003 due to its specific type of wetlands supporting high biodiversity in the western Terai region (IUCN, 1998; Kafle, 2005; Lamsal *et al*., 2014). The depth of the water in the lake is up to 6.5 m (IUCN, 1998). This area is surrounded by Sal (*Shorea robusta*) forest and non-timber natural forest, and is associated with aquatic weeds and grassy marshes. The lake complex is an important habitat for a nationally endangered and globally threatened bird species; hence it has also been declared as IBA (Important Birds Area) by government (BCN and DNPWC, 2012). It also functions as an important corridor for wildlife movement between Bardia National Park and Shuklaphanta National Park (Lamsal *et al*., 2014). A total of 244 plant species, 140 bird species, 27 fish species, and 34 mammals were reported from the lake complex (Baral, 1992). Bista *et al*., (2010) have recorded 8 amphibian species from the lake complex. The indigenous communities (more than 50% Tharus) depend on the lake complex for fishing, collection of fodder, fuelwood, wild foods, medicinal plants and livestock grazing (Sah and Heinen, 2001; Siwakoti and Karki, 2009).

Data Collection

The forest was surveyed along the foot trial inside the forest. A total of 38 quadrants (each of 10m x 10m at interval of 300 m) were laid on ground along the foot trail. Also, the nested plots of 3m x 3m and 1m x 1m within the 10m x10m plot were laid on the lower right-hand side corner for shrubs and herbs observation, respectively (Dongol, 2002). Secondary data were collected from online portals like Google scholar and Research gate (Gautam *et al*., 2020; Timilsina *et al*., 2020; Miya *et al*., 2020). Aquatic floral species were not studied due to inaccessibility to the water bodies. Collected floral species were identified in the field with the help of experts and local peoples. Plant species unidentified in the field were collected, tagged, dried and brought to the Central Department of Botany for further identification.

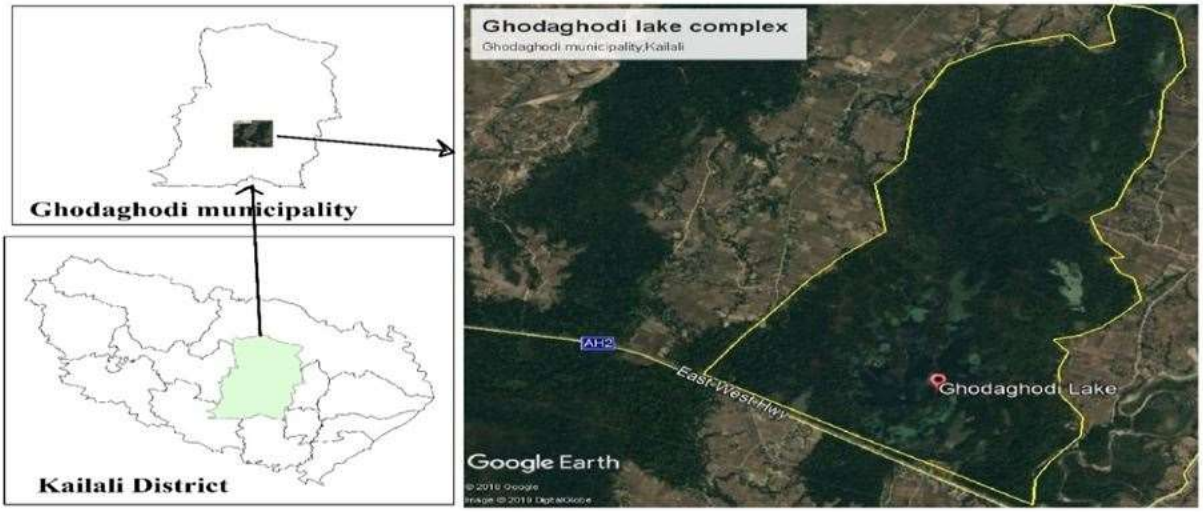

Fig. 1: Map of the Ghodaghodi Lake Complex, Western lowland of Nepal.

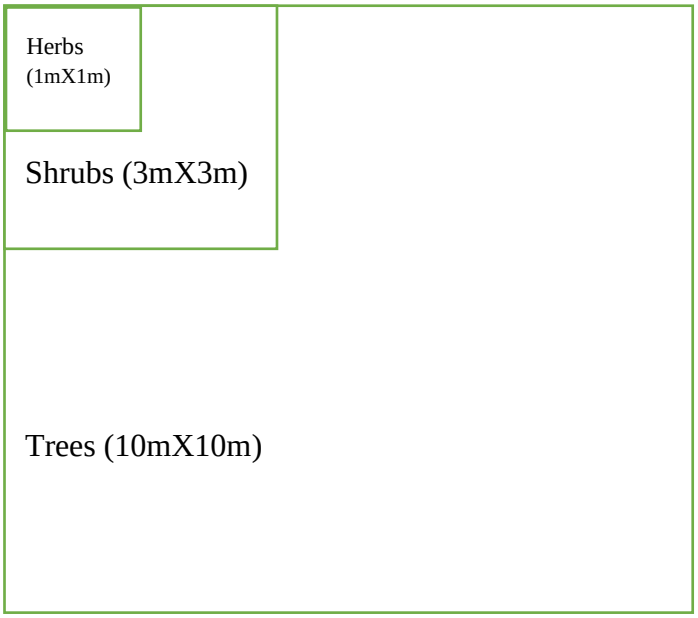

Fig. 2: Field Plot Layout

Data Analysis

Data were pooled and analyzed with SPSS software. Importance value index (IVI) gives the overall importance of each species in the community structures (Curtis and Mcintosh, 1950). IVI is calculated as the sum of RF; RD and RA. The detail of each formula is given below:

$$\text{Frequency (F)} = \frac{\text{Number of sampling units (quadrates) in which a species occurs}}{\text{Total number of sampled units studied}} x100$$

$$\text{Relative Frequency (RF} = \frac{\text{Frequency of individual species}}{\text{Sum of the frequencies for all species}} * 100$$

$$\text{Density (D)} = \frac{\text{Total number of individual in all sampling units}}{\text{Total number of sampled units studied}} * 100$$

$$\text{Relative Density (RD)} = \frac{\text{Density of individual species}}{\text{Total density of all species}} * 100$$

$$\text{Abundance (A)} = \frac{\text{Total number of individuals in all sampling units}}{\text{Total number of sampling units of occurrence}}$$

$$\text{Relative Abundance (RA)} = \frac{\text{Abundance of individual species}}{\textit{Total abundance of all the species}} x100$$

Important Value Index (IVI) = RF + RD + RA

Results and Discussion

A total of 54 terrestrial plant species including 25 trees, 7 shrubs and 22 herbs were recorded in GLC (Lamsal *et al*., 2014). In our study, we have recorded 50 terrestrial plant species from 27 families, among which 33 were trees (66%), 8 shrubs (16%), and 9 herbs (18%) (Figure 3). Similarly, (Kafle, 2005; Sah *et al*., 2002; IUCN, 1997) had identified 35, 217 and 137 terrestrial plant species respectively at GLC. Huge decline in terrestrial plants in recent year might be due to the change of season or vegetation and threats from increasing population, overexploitation of lake resources, unsustainable harvesting, illegal poaching and changes in land use (Lamsal *et al*., 2014).

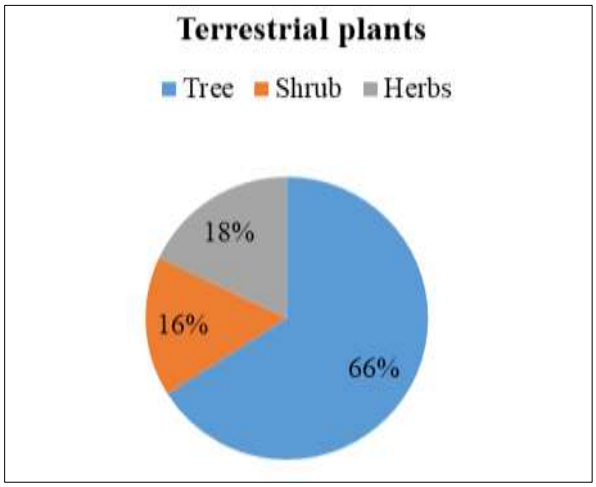

Fig. 3: Habits of terrestrial plants

The highest number of plant species was represented by family- Fabaceae (7 species) followed by Moraceae (5 species), Asteraceae (4 species), Lythraceae (3 species) and eight families representing each of two species and 15 families representing each of single specimen. Lamsal *et al*., (2014) and Sah *et al*., (2002) had also recorded highest number of plant species from Fabaceae family from this area during their study. Pandey and Ghimire (2020) have also recorded Fabaceae as a dominant family in their study in Kanchanpur district where they reported 148 plant species under 59 families. The present study also agrees with the findings of (Anbarashan *et al*., 2011; Pathak and Baniya, 2017; Dhami, 2008) who reported Fabaceae as a dominant family in their studies. This similarity may conclude that tropical lowland is suitable habitat for plants of Fabaceae family. The list of the all trees, herbs and shrubs with their important value index (IVI) is given in Table 1, 2 and 3 respectively.

The major terrestrial tree species prevalent there were *Shorea robusta*, *Terminalia tomentosa* and *Syzygium cumini.* Similarly, major Shrub species were *Calotropis gigantea*, *Colebrookea oppositifolia* and *Murraya koenigii and Aerva lanata*, *Phyla nodiforia* and *Barleria cristata* were the major herb species which were same as (Lamsal *et al*., 2014). *Gardenia campanulata* (rare spiny shrub with highly restricted distribution inside Nepal) was recorded which was previously recorded by (Lamsal *et al*., 2014).

In this study, *Terminalia tomentosa* of Combretaceae family have the highest IVI (45.67) among the tree species followed by *Syzygium cumini* of Myrtaceae family (Table 1). Among the shrub species *Calotropis gigantea* of Apocynaceae family has highest IVI (68.56) followed by *Murraya koenigii* of Rutaceae family (Table 2). Similarly, among the herbs, *Aerva lanata of* Amaranthaceae family has highest IVI (54.13) followed by *Barleria cristata* of Acanthaceae family. Among the recorded species *Ageratum conyzoides*, *Artemisia vulgaris* and *Ipomea carnea* are invasive species for Nepal.

Table 1: Important value Index of trees around the GLC

S.N.	Scientific Name	Local name	Family Name	A	RA	F	RF	D	RD	IVI
1.	*Acacia catechu*	Khayar	Fabaceae	4.33	4.02	23.68	3.20	102.63	2.99	10.21
2.	*Adina cardifolia*	Haldu	Rubiaceae	2.25	2.09	31.58	4.27	71.05	2.07	8.43
3.	*Aegle marmelos*	Bel	Rutaceae	1.8	1.67	26.32	3.56	47.37	1.38	6.61
4.	*Alstonia scholaris*	Chatiban	Apocynaceae	1	0.93	2.63	0.36	2.63	0.08	1.37
5.	*Araucaria sp.*	Christmas Tree	Araucariaceae	3	2.78	2.63	0.36	7.89	0.23	3.37
6.	*Artocarpus heterophyllus*	Katahar	Moraceae	1.5	1.39	5.26	0.71	7.89	0.23	2.33
7.	*Azadirachta indica*	Nim	Meliaceae	2	1.86	2.63	0.36	5.26	0.15	2.37
8.	*Bauhinia purpurea*	Taaki	Fabaceae	1.57	1.46	18.42	2.49	28.95	0.84	4.79
9.	*Bombax ceiba*	Simal	Malvaceae	2	1.86	2.63	0.36	5.26	0.15	2.37
10.	*Cassia fistula*	Raj brikshya	Fabaceae	2	1.86	2.63	0.36	5.26	0.15	2.37
11.	*Dalbergia latifolia*	Satisal	Fabaceae	2	1.86	2.63	0.36	5.26	0.15	2.37
12.	*Dalbergia sissoo*	Sissoo	Fabaceae	10	9.28	2.63	0.36	26.32	0.76	10.4
13.	*Eurya acuminata*	Jhigane	Theaceae	3.11	2.89	47.37	6.41	147.37	4.29	13.59
14.	*Ficus benghalensis*	Bar	Moraceae	1	0.93	5.26	0.71	5.26	0.15	1.79
15.	*Ficus benjamina*	Sami	Moraceae	1	0.93	2.63	0.36	2.63	0.07	1.36
16.	*Ficus racemose*	Dumri	Moraceae	1.5	1.39	5.26	0.71	7.89	0.23	2.33
17.	*Ficus religiosa*	Pipal	Moraceae	1.4	1.29	13.16	1.78	18.42	0.53	3.6
18.	*Grewia optiva*	Bhimal	Tiliaceae	1	0.93	5.26	0.71	5.26	0.15	1.79
19.	*Hyophorbe lagenicaulis*	Bottle palm	Arecaceae	6	5.57	2.63	0.36	15.79	0.46	6.39
20.	*Lagerstroemia indica*	Asare	Lythraceae	4	3.71	18.42	2.49	73.68	2.15	8.35
21.	*Lagerstroemia parviflora*	Botdhaero	Lythraceae	3	2.78	76.32	10.32	228.95	6.68	19.78
22.	*Mallotus philippinensis*	Rohini	Euphorbiaceae	5.17	4.79	76.32	10.32	394.74	11.5	26.61
23.	*Mangifera indica*	Aap	Anacardiaceae	5.33	4.95	7.89	1.08	42.11	1.23	7.26
24.	*Ougenia dalbergoides*	Sandan	Fabaceae	1.6	1.49	26.32	3.56	42.11	1.23	6.28
25.	*Phyllanthus emblica*	Amala	Phyllanthaceae	1	0.93	2.63	0.36	2.63	0.08	1.37
26.	*Saraca asoca*	Ashoka	Fabaceae	8.5	7.89	5.26	0.71	44.74	1.30	9.9
27.	*Schima wallichii*	Chilaune	Theaceae	1	0.93	2.63	0.36	2.63	0.07	1.36
28.	*Semecarpus anacardium*	Bhalayo	Anacardiaceae	1.05	0.97	57.89	7.83	60.53	1.76	10.56
29.	*Shorea robusta*	Sal	Dipterocarpaceae	5.86	5.44	76.32	10.32	447.37	13.04	28.8
30.	*Syzygium cumini*	Jamun	Myrtaceae	8.82	8.19	73.68	9.96	650	18.95	37.1
31.	*Terminalia bellerica*	Barro	Combretaceae	3.2	2.97	13.16	1.78	42.11	1.23	5.98
32.	*Terminalia tomentosa*	Asna	Combretaceae	9.74	9.04	89.47	12.09	871.05	25.40	46.53
33.	*Ziziphus jujube*	Bayar	Rhamnaceae	1	0.93	7.89	1.07	7.89	0.230	2.23

Table 2: Important value Index of shrubs around the GLC

S.N.	Scientific Name	Local Name	Family Name	A	RA	F	RF	D	RD	IVI
1.	*Artemisia vulgaris*	Titepati	Asteraceae	1	4.28	2.63	1.12	2.63	0.36	5.76
2.	*Calotropis gigantea*	*Aank*	Apocynaceae	4.00	17.11	52.63	22.47	210.53	28.98	68.56
3.	*Colebrookea oppositifolia*	Dhursuli	Lamiaceae	2.85	12.19	34.21	14.61	97.37	13.41	40.21
4.	*Gardenia campanulata*	Indrakamal	Rubiaceae	2.60	11.12	26.32	11.23	68.42	9.42	31.77
5.	*Ipomea carnea*	Beshram	Convolvulaceae	5.17	22.11	15.79	6.74	81.58	11.23	40.08

Table 2: Important value Index of shrubs around the GLC

S.N.	Scientific Name	Local Name	Family Name	A	RA	F	RF	D	RD	IVI
6.	*Murraya koenigii*	Kadi patta	Rutaceae	3.07	13.13	36.84	15.72	113.16	15.58	44.43
7.	*Phoenix acaulis*	Khajuri	Arecaceae	2.44	10.43	23.68	10.11	57.89	7.970	28.51
8.	*Woodfordia fruticosa*	Dhayero	Lythraceae	2.25	9.62	42.11	17.97	94.74	13.04	40.63

Table 3: Important value Index of herbs around the GLC

S.N.	Scientific Name	Local Name	Family Name	A	RA	F	RF	D	RD	IVI
1.	*Aerva lanata*	Khari	Amaranthaceae	5.36	16.55	36.84	16.09	197.37	21.49	54.13
2.	*Ageratum conyzoides*	Ganaune	Asteraceae	2	6.17	2.63	1.14	5.26	0.57	7.88
3.	*Asteracantha longifolia*	Kokilakshya	Acanthaceae	3.30	10.19	26.32	11.4	86.84	9.45	31.04
4.	*Bacopa monnieri*	Brahmi	Plantaginaceae	3.08	9.51	31.58	13.79	97.37	10.60	33.9
5.	*Barleria cristata*	Bhede kuro	Acanthaceae	5.17	15.96	31.58	13.79	163.16	17.76	47.51
6.	*Cirsium wallichii*	Thakal	Asteraceae	4.00	12.35	36.84	16.09	147.37	16.04	44.48
7.	*Eryngium foetidum*	Kaade	Apiaceae	1.6	4.94	13.16	5.74	21.05	2.29	12.97
8.	*Phyla nodiflora*	Kurkure jhar	Verbenaceae	5.20	16.05	26.32	11.49	136.84	14.89	42.43
9.	*Vernonia cinerea*	Dandotapala	Asteraceae	2.67	8.245	23.68	10.34	63.16	6.87	25.455

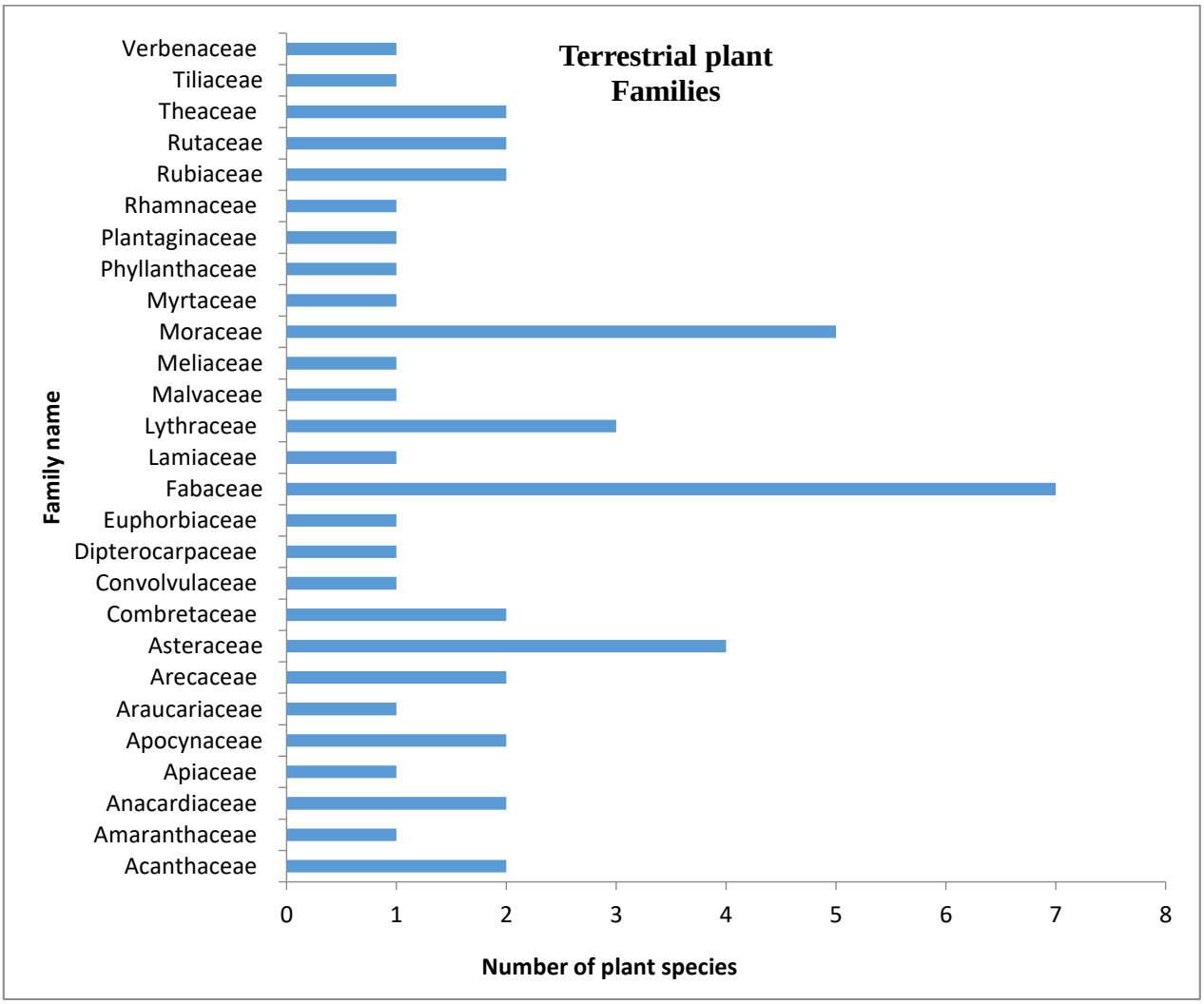

Fig. 4: Family-wise diversity of terrestrial plants

Conclusion

The study reveals that the Ghodaghodi Lake complex is rich in terrestrial floral diversity 50 species representing 33 tree species, 8 shrub species and 9 herb species. *Terminalia tomentosa* has highest IVI (46.53) among tree species. Similarly, *Aerva lanata* has highest IVI (54.13) among herb species and *Calotropis gigantea* has highest IVI (68.56) among the shrub species. The Fabaceae family (n=7) represented the maximum numbers of plants species followed by Moraceae family. This study is representative of only one season (winter), hence many other species especially herbs could be recorded during other season which might be dried during winter.

Authors' Contribution

All authors equally contributed at every stages of research work and preparation of the manuscript. Final form of manuscript was approved by all authors.

Competing Interests

Authors do not have any competing interests with the present publication.

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