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An Overview of Floral Diversity in Wetlands of Terai Region of Nepal

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Abstract

Based on altitudinal variations, Nepal is divided into 7 physiographic zones. The southern lowland constitutes the Terai zone (below 300m) and is a part of alluvial Gangetic plain lying between the Indian border and the outer foothills (Siwaliks). Biogeographically, the area falls in the Indo-Malayan region and is characterized by tropical climate. The area is rich in floral diversity and contains about 1885 species of vascular plants. However, a detail inventory is yet to be prepared. The region also houses a number of habitats such as wetlands, croplands, grasslands, forests, riverine floodplains and so on. Terai is an important area for wetland habitat where exists 80 natural lakes, 55 important floodplains, 12 marshes as well as reservoirs and canals. In addition, there are several rivers/streams, seasonally flooded grasslands, rice fields and man made aqua-cultural ponds. The present paper highlights wetland dependent endemics, threatened plant species, and also gives an overview about the species composition, habitat wise distribution, uses and threats. Attention has been given to focus the Koshi Tappu and Ghodaghodi wetlands.

***Keywords*:** Flora, Ghodagodi, Koshi Tappu, Terai, , Wetlands

Introduction

Nepal lies on the southern slope of central Himalayas and occupies a total area of 147, 181 sq. km. between the latitudes 26° 22' and 30° 27' N and the longitudes 80 °40' and 88° 12' E. The average length of the county is 885 km from east to west and the width varies 145 km to 241 km from north south. About 86 % of the total land area is covered by hills and high mountains, and the remaining 14 % are flat lands of Terai. Based on wide altitudinal variation (60-8848 m), the climate is broadly classified into cold Arctic/Nival (above 3000 m), cold temperate (2000-3000 m), warm temperate (1500-2000 m), subtropical (1000-1500m) and tropical (below 1000m). The country is divided into 7 physiographical regions which occur in the following order from south to north: Terai, Siwaliks, Mahabharat lekh, Midhills, Himalayas, Inner Himalayas and The Tibetan Marginal Mountain Range (Hagen, 1998).

The country is extremely rich in terms of floral diversity in proportion to its size. Nepal comprises only 0.09% of the land area on a global scale but it possesses 2.7% of the world's recorded flowering plants. A total of 5,856 species of flowering plants, 28 species of gymnosperms (20 species are indigenous

belonging to 13 genera and 10 families), 853 species of bryophytes and 380 species of pteridophytes have been recorded from Nepal (Wilson, 1988, 1992; Akiyama *et al.,* 1998 and Koba *et al*., 1994). Similarly, 687 species of algae, 465 species of lichens and 1500 species of fungi have been enumerated from the country (BPP, 1995).

The Terai is a flat and valuable agricultural land in the southern Nepal. It lies at an altitude of 60–300m between the Indian border and outer foothills of Siwaliks, where over 48% of Nepal population live (Census Report 2001). The region is heavily traversed by the major river systems of the country. The soil of the region is a part of alluvial-Gangetic plains including the Bhabar region and the alluvial fans of the Siwaliks. It exhibits the tropical type of climate. The mean temperature in the area is more than 12^{o}C during the coldest month (December-January) and the mean temperature ranges from 23 to 30^{o}C during the hottest month (June–July).The annual precipitation ranges from 1,000 to 2,500 mm. The Terai including Siwalik region (< 1000 m) houses 1885 species (37 %), mid-hills 3,364 species (65 %) and highland over 2000 species (38.7 %) of angiosperms of Nepal (BPP, 1995). This region has also 81 species (21 %) of Pteridophytes and 61 species (8 %) of Bryophytes (BPP, 1995). Information on aquatic and the lower group of plants is not adequate. The detail inventory of aquatic flora of Nepal's wetlands is not available, except few wetlands sites present in Pokhara, Kathmandu and Terai region. Nepal has only fresh water wetlands. The term wetlands indicates the areas with river/streams/ creeks, river floodplains, high altitudinal glacial lakes, ox-bow lakes, hot springs, ponds, swamps, marshes and human-made wetlands.

Materials and methods

The article is mainly based on review of the literature (Bista *et al*., 2002; Bhandari, 1998; BPP, 1995; Hara *et al*., 1978, 1979 and 1982; Sah, 1997; IUCN, 1998; Jha, 2000; Siwakoti and Sharma, 1996; Siwakoti and Verma 1999; Press et al*.,* 2000; WMI/IUCN Nepal, 1994*)* and field observations. All the flowering plants occurring in Terai wetlands including the adjoining forest, grassland, fallow land and agricultural land have been recorded but more attention has been given to the Koshi Tappu and Ghodaghodi wetlands, both of these sites are Ramsar sites (a wetland of International significance). The Koshi Tappu lies in eastern Nepal amidst Sunsari, Saptari and Udayapur districts whereas; Ghodaghodi lies in Kailali district of far western Nepal.

Results and discussion

A total of 720 species of vascular plants including pteridophytes, Gymnosperms and Angiosperms have been recorded from wetlands and their adjoining ecosystems of Terai (Table 1). Out of these, 23 species belongs to pteridophytes, two species belongs to gymnosperms, 469 species belongs to dicots and 226 species to monocots. Koshi Tappu is the first Ramsar site in Nepal housing 670 species of vascular plants (ferns and fern allies 22 species, dicots 448 species and monocots 200 species). Similarly, Ghodaghodi wetland complex houses 473 species of vascular plants (ferns and fern allies 18 species, dicots 339 species and monocots 116 species).

On the basis of habits, there are 98 species of trees, 67 species of shrubs, 68 species of

climbers and 487 species of herbs (Table 2). Habitat analysis reveals that 318 species are wetlands dependent in Terai region. Out of the wetlands dependent species, 12 species are floating species, 16 species are submerged and 290 species are amphibious/emergent. Of the total amphibious species, 254 species are exclusively found in aquatic habitats, 11 species in riverine and ravine forest habitats, 21 species occur in savanna grasslands and 42 species in anthropogenic lands. There are 310 species of plants occurring in anthropogenic areas. Similarly, 190 species of plants occur in forest, 31 species in pseudo-steppe grasslands and 53 species in agricultural lands. The cultivated species have been not included in the paper. The Koshi Tappu and Ghodaghodi wetlands house 284 and 195 species of vascular plants respectively.

Table1. Floristic Analysis based on species composition in Terai wetlands

Group	Family	Genus	Total Species
Pteridophytes	13	16	23
Gymnosperms	2	2	2
Dicotyledons	90	320	469
Monocotyledons	24	123	226
Total	129	461	720

Attempt was also made to document the economically important plants by making field visit and consulting literature (Manandhar, 1986, 1990; Siwakoti & Siwakoti, 1998, 2000, Siwakoti *et al.*1997; Rajbhandari, 2001). A large number of recorded species are economically important for various purposes (Table 3). Local people use 111 species of plants for herbal treatments to cure various ailments. These include 2 species of pteridophytes, 96 species of dicotyledons and 13 species of monocotyledons. There are 46 species of wild edible plants belonging 4 species of pteridophytes, 32 dicots and 10 monocots. Similarly, 11 species of wild plants have a cultural value for different ethnic groups. Over 85 species of wild plants are used as bee forage. There are 15 species of plants considered as wild genetic resources of agro-biodiversity (Shrestha and Shrestha, 1999). About 12 species of plants are used by wetland dependent community, particularly in Koshi Tappu for preparing different domestic crafts for trade as well as personal uses.

Invasive Alien Species

Over 166 alien and invasive plant species have been recorded in Nepal (Tiwari *et al.*, 2005). Out of these, 21 species are identified as most problematic species. These species are ranked under 4 categories by Invasiveness Rank Form (Tiwari *et al.,* 2005). Among these, 7 species are wetland dependent, namely *Eichhornia crassipes*, *Ipomoea carnea* ssp. *fistulosa, Mikania micrantha, Alternanthera philoxeroides, Myriophyllum aquaticum, Leersia hexandra* and *Pistia stratiotes.* In addition, there are about 60 alien species introduced in wetland habitat of Nepal's Terai. The introduction of alien species is one of the major problems for the degradation of many significant wetland sites including Koshi Tappu and Ghodaghodi sites threatening the existence of associated native species. The major invasive species in Koshi Tappu are *Eichhornia crassipes, Mikania micrantha, Ipomoea carnea* ssp. *fistulosa, Alternanthera philoxeroides, A. sessilis,* etc. Similarly, Ghodaghodi lake complex is invaded by *Ipomoea carnea* ssp. *fistulosa, Eichhornia crassipes,* etc. In addition, the *Ipomoea aquatica, Pistia stratiotes, Alternanthera paronychiodes , Mimosa pudica, Paspalum*

distichum,P.conjugatum,Ludwigia octovalvis, L. hyssopifolia, Xanthium strumarium, Soliva anthemifolia are also spreading in the wetland sites of Terai. The introduction of alien species is leading to habitat destruction and depletion of native species. Majority of invasive species are of neo-tropical origin (South America) and have been introduced through numerous pathways.

Agro-Biodiversity

Nepal's Terai wetlands also holds several species of wild cultivers and wild relatives of cultivated crops, including 4 species of wild rice (*Oryza rufipogon* ; *Oryza nivara; Oryza granulata; Oryza officinalis* and two species of wild relatives of rice(*Hygrorhyza aristata* and *Leersia hexandra*) (IUCN, 2004). Among these, *O. granulata* is upland species and other 3 species are wetland dependent. The *O. rufipogon* is distributed in Terai -from Mahendranagar (west) to Biratnagar (east). Similarly, *O. nivara is* reported from Kapilvastu, Nepalgunj and Mahendranagar. The species is generally mixed with *O. rufipogon. The O. granulata* is reported from the Lothar forest of Chitwan and in the Kankai irrigation headwork of Jhapa district. *O. officinalis* is reported from Sundarpur Agricultural Farm of Kanchanpur district and also from Nijgadh (Bara district*). O. officinalis* is a rare species for Nepal. Some times *Oryza sativa f. spontanea* (weedy wild rice) occurs in terai wetlands mixing with cultivated rice (*O. sativa*) and wild rice. *O. rufipogon* is common in both Koshi Tappu and Ghodaghodi areas*. Perilla frutescens* (Silam – a high value aromatic cash crop) commonly occur as wild in Ghodaghodi. The wetland genetic resources of agro-biodiversity in mid-hills and highlands are least known.

Endemic species

Nepal houses 246 species of flowering plants as endemic *i.e*. 4.8% of total species of flowering plants (Shrestha and Joshi, 1996).The highest concentration of endemic plants (91 species) occurs between 3000-4000 m altitudes in central Nepal. Terai/Siwaliks has 13 species of endemic plant species. About 26 endemic species are considered as wetland dependent (IUCN, 2004). Among these, 8 species occur in Terai wetlands (Table 4). One species, *Begonia tribenensis* has been reported from Koshi Tappu in (Rao, 1969). It is a tuberous herb occurring in shade on rock cut surfaces (Shrestha and Joshi, 1996). Later, it has not reported by other workers.

Globally / nationally threatened species:

Nepal's Terai supports a large number of globally/nationally significant plant species which are threatened due to habitat disturbance, human encroachment, illegal export and over exploitation. Nepal has 91 threatened plants (Shrestha and Joshi, 1996; CAMP, 2001). Of these, 11 species are wetlands dependent. However, IUCN Red List identifies 20 species of vascular plants in Nepal as threatened under different categories (Walter and Gillett, 1998). The threat status of many wetlands dependent species are yet to be assessed.

The government of Nepal has merited 17 species of plants under legal protection (in pursuant with section 70(a) of the Forest Act, 1993, amended 2001), out of these 6 species (including 3 wetlands dependent) occur in Terai (Table 5).

Table 2. Habitat-wise distribution of plant species in Terai

Habitat	Climber	Herb	Shrub	Tree	Total
Wetland dependent	6	287	9	16	318
Forest Plant	35	89	32	14	190
Anthropogenic areas	18	203	16	73	310
Grassland	1	30	-	-	31
Cropland	2	40	2	9	53

Table 3. Ethno-Botanical Uses of Flora of Terai

Use	Wetlands dependent species	Forest species	Anthropogenic area species	Grassland species	Agricultural land	Total species
Medicine	21	42	51	03	03	111
Wild food	17	23	21	-	05	46
Socio-religious	0 2	01	05	-	-	11
Wild genetic resources of agrobiodiversity	11	01	08	-	01	15
Domestic purposes	11	07	03	05	-	12
Miscellaneous	06	03	05	-	01	20

Table 4. Names of endemic Species in Terai

Family	Species	Distribution(m)	East	Cent	West
Eriocaulaceae	*Eriocaulon exsertum*	200-300	*		
	E. obclavatum	200-300	*		
Fabaceae	*Ormosia glauca*	200-1000	*	*	*
Rosaceae	*Prunus jajarkotensis*	900-1000			*
Lythraceae	*Rotala rubra*	500-1000	*	*	
Begoniaceae	*Begonia tribensis*	130-600	*	*	
Oleaceae	*Jasminium amabile*	800	*		
Saliaceae	*Salix plectilis*	200	*		

*=present

Table 5. Plants under legal protection

Scientific Name	Remarks
1. Orchis latifolia	Plants banned for collection, use, sale and distribution, transportation and export
2. Juglans regia	do
3.Picrorhiza kurroa (Neopicrorhiza scrophulariifolia)	do
4. Valeraiana jatamansi	Plants banned for export except processed with permission of Department of Forests
5. Rauvolfia serpentina (Terai)	do
6. Cinnamomum galucescens	do
7. Valeriana wallichii	do
8. Lichen	do
9. Rock salt	do
10. Abies spectabilis	do
11. Taxus baccata	do
12. Cordyceps sinensis	do
13. Michelia champaca	Plants banned for transportation, export and felling for commercial purposes
14.Acacia cathechu (Terai)- wetlands dependent	do
15. Shorea robusta (Terai)	do
16. Bombax ceiba (Terai)- wetlands dependent	do
17. Dalbergia latifolia (Terai)- Wetlands dependent.	do
18. Pterocarpus marrsupium (Terai)	do

Locally Threatened Species in Koshi Tappu and Ghodaghodi areas

Diplazium esculenta (young frond -vegetable)
Terminalia chebula (fruit-medicine)
Phyllanthus emblica (fruit-medicine)
Tamarindus indica (fruit-prickle)
Aegle marmelos (fruit and leaves- medicinal and cultural value)
Madhuca longifolia (flower- cultural value and local liquore)
Acorus calamus (rhizome-medicines)
Phonix loureir (leaves-mat; fruit and exude-edible)
Calamus tenuis (stem- domestic crafts)
Typha angustifolia (leaves-mat, mattresses- Batar ethnic group)
T. elephantina(leaves- mat, mattresses- Batar ethnic group)
Costus specious (rhizome-medicine)
Cyperu corymbosus (culms- mat, mattress- Bantar ethnic group)

Nationally Threatened species in Koshi Tappu and Ghodaghodi Sites

Koshi Tappu Area:

Endangered: *Oroxylum indicum*, *Crateva unilocularis*, Operculina turpethum

Vulnerable: *Asparagus racemosus*, *Alstonia scholaris*, *Butea monosperma*, *Curculigo orchioides*, *Piper longum*, *Tinospora sinensis*

Data Deficient: *Dalbergia latifolia.*

Three species protected under the Forest Act 1993: *Acacia catechu, Bombax ceiba, Shorea robusta*

Ghodaghodi Lake Complex:
Critically Endangered: *Pterocarpus marsupium*
Endangered: *Operculina turpethum, Oroxylum indicum;*
Vulnerable: *Asparagus racemosus, Butea monosperma, Curculigo orchioides, Piper longum*
Data Deficient: *Dalbergia latifolia, Magnifera indica*
Four species protected under the Forest Act 1993: *Acasia catechu, Bombax ceiba Pterocarpus marsupium Shorea robusta*.
Source of wild genetic material for cultivated varieties: Wild Mango (*Magnifera indica*), Wild Rice (*Oryza rufipogon*), Wild Perilla (*Perilla frutescens*).

List of Threatened Wetlands Dependent Plants (IUCN Red list category)

Name	Status
Dalbergia latifolia	DD
Operculina turpethum	EN
Butea monosperma	VU
Aconitum balangrense	EN
Neopicrorhiza scrophulariifolia	VU
Swertia multicaulis	DD
Valerina jatamansii	VU
Crateva unilocularis	*EN*
Piper longum	*VU*
Alstonia scholaris	VU
Panax pseudo-ginseng	VU

Conclusion

The Terai wetlands support several endemic and globally threatened species. There are about 20 indigenous ethnic communities traditionally dependent on wetland products or services. However, these are getting lost or degraded by human activities or by some natural processes. Major threats are modification of land use, unsustainable management of wetlands, encroachment, over exploitation of resources, over grazing, colonization by invasive alien species, etc. There is an emerging need to promote the wetland conservation in Nepal's Terai to reduce the degradation of wetlands and depletion of native species. This is a high time to give proper attention for conservation of native floral diversity and habitats. Effective implementation of Nepal Biodiversity Strategy (2002) and the National Wetland Policy (2003) is one of the important instruments in this direction.

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