



## RESEARCH PAPER

## OPEN ACCESS

## Determination of floristic diversity of bela forest of Indus between Tarbela and Khairabad, Pakistan

Behra Mand Khan, Ahmad Hussain\*, Ume Habiba, Muhammand Salim,  
Ikhtiham Khan

*Department of Forestry and Wildlife Management, University of Haripur, Haripur,  
Khyber Pakhtunkhwa, Pakistan*

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### Abstract

A research investigation was carried out in bela forest of Indus between Tarbela and Khairabad, Pakistan to document the existent vegetation and floristic diversity. Floristic surveys were conducted during July 2015 to June 2016 for the record of plant biodiversity. The bela forests stretched to 52 km in length from Tarbela to Khairabad in study area. Fifty two random plots were taken along Indus River at four selected sites. All the species within each plot was noted and identified. The determined voucher specimens were deposited in the herbarium and were identified from literature and PMNH (Pakistan Museum of Natural History). Local herders were interviewed to get local names of the plants and matched with PMNH data. Overall 33 plant species belonging to 24 families were identified. Of those, 9 species of tree, 21 species of herbs and 3 species of shrubs were identified and recorded. The herbs were found as the dominant in the flora of Indus between Tarbela and Khairabad (64%), followed by trees species (27%) and least species recorded were shrubs with a percentage of 9. Majority of the of plant 34% was present on exposed sand stone patch, followed by vegetation (30%) on Flat Patches and the lowest (18%) percentage of flora was recorded on both stony and wet patches. The bela forest showed unique pattern of distribution of flora across its length from Tarbela to Khairabad and need to be conserved for sustainable use.

\* **Corresponding Author:** Ahmad Hussain ✉ [ahmaddof@yahoo.com](mailto:ahmaddof@yahoo.com)

## Introduction

Forest is an important resource that extensively contribute to economy and provide stable environment, climate stability of that area, regulate the precipitation patterns and control soil erosion which minimize the load of sedimentation in rivers (Lee and Joung, 1998). Forest plays an important role in livelihood generation. It provide shelter, clothing, food, fuel wood and most of the people live in poverty and depend upon forests, they generate income by selling forest products and also through employment (FAO, 2006).

The Riverine forests of the arid and semiarid areas of Africa and Asia have a much diversity of flora and fauna (Hughes, 1988). The riverine grassland of Taraihas been reported as the world most productive areas which are found at the Himalayas foothill in India and Nepal (Lehmkuhal, 1989). In Pakistan, forests cover an area of 4.20 million hectares which is 4.8% of the total area (Wani, 2002). Bela forest (riverine forests) cover an area of 0.296 million hectare which is 6.5 percent of the total forest cover, out of which 0.158 million ha is production forest and 0.138 million ha is protective forest (Wani, 2002). Bela forests are found on both sides of river Indus and flood plains which are commonly known as "riverine forest". Bela forests are found mostly in Sindh and Punjab province along the Indus river banks and dependent on river flooding throughout the monsoon season. Bela forest in Sindh cover an area of 0.241 million hectares (Saddiqui *et al.*, 2004) whereas the Punjab province own 0.054 million (Wani, 2002).

For the sustainable growth of Bela forest, six week per year of flooding has been noted as necessary. The availability and presence of large quantity water create these forests a valuable drought reserve, the riverine forests also giving access to the nectar source on neighboring areas (ESFM plan, 2008). The major species of these forests are *Tamarix dioica*, *Prosopis cineraria*, *Dalbergia sissoo*, *Acacia nilotica* whereas *Populus euphratica* is rarely recorded in that forest (Sheikh, 1993). These forests have significance to support faunal diversity like hog deer, wild boars, sand grouse, jackals, wolves, deer, partridges and porcupines (Saddiqui *et al.*, 2004). During the months

of high rains i.e. July, August and September these areas experience flood and the floodwater comes out of the both sides of riverbanks (FAO, 2009).

Bela forests were also affected seriously by minimizing or no flooding due to removals or diverging rivers water by construction of barrages and dams. Water scarcity is increasing which decreased the flow of water in rivers that cause serious impact on these forests. (FAO, 2009). It is expected that in 2020 the Bela forest in Pakistan will become reduced upto 120,000 hectare (FAO, 2009).

Little or no inventory of floristic composition and diversity were recorded in the bela forest of Pakistan along the Indus River, particularly in the province of Khyber Pakhtunkhwa. As the sustainable livelihood of local community was at risk due to many reasons, an investigation was found appropriate to know about the potential of the bela forest. The objective of the study was to explore, identify and document the flora of bela forest of Indus between Tarbela and Khairabad.

## Materials and methods

Following methodology was adopted to achieve the set of objectives.

### Study Area

The study area "Bela forest of Indus between Tarbela and Khairabad" is located in district Swabi and district Nowshara. These forests are found on bank of Indus River. The study area lied on right side of bela forest of Indus between Tarbela and Khairabad. During the months of high rains, i.e. July, August and September, these areas experience flood. The deposited mud through floodwater makes the soil very fertile. This land is called alluvial soil. Climate is sub-tropical arid. Forest vegetation is due to deep moist soil as the river water percolates in its sides and gets deposited in the shallow depths of the surrounding regions. Erosion and deposition are common features. The Bela forest of Indus between Tarbela to Khairabad is located in the southern western part of Khyber Pakhtunkhwa. Its elevation is ranging from 268 to 344 meters. It lies between 33-8', 33-90' N and 72-5', 72-21' E.

These bela forests stretch to 52 km in length from Tarbela to Khairabad in study area. The study area consisted of 15 villages/hamlet, Right Bank Colony, Galla, Battakara, Pontia, Zarobi, Dhok, Gar Munara, Rana Dherai, Hund, Harian, Beka, Tanu, Jabbar, AllaDher, Khairabad. The total population of these villages/hamlets are 1, 67,550. Geographically, the significance is due to its boundaries that border Haripur district, Swabi district in North, Attock district of Punjab province in the South, the Haripur district in the East as well as the Nowshera district in the West.

#### Climate

The climate of the area is harsh. The total rainfall is small and erratic which show variation due to constructing relief differences in the area. The summer is hot, with mean monthly temperature remaining at 27°C from May to September. The hottest months are June and July that have maximum temperature of 42°C and 40°C, respectively. There is slight drop in temperature in August (37°C) with oppressive heat due to high humidity. October is a transition from summer to winter. Winters are cold having temperatures below then 20°C. The coldest month is January (10°C). Since the area is transition between summer monsoon and western disturbance, therefore, rain is received both during monsoon (350mm) and winter (275mm). August is the wettest month (175-75mm), receiving more than 50% of the total rainfall. The annual rainfall is 775mm (Said, 1978).

#### Methodology

The study involved the utilization of various tools for information assimilation. Floristic surveys were carried out during July, 2015 to June, 2016 for the record of plant biodiversity of the study area. The bela forests stretched to 52 km in length from Tarbela to Khairabad in study area. Fifty two random plots were taken along Indus River. For trees 10 × 10m plot, for shrubs 5 × 5m plot and for herbs 1 × 1 m was taken in each plot. All the species within each plot was noted and specimens of plants were collected and then on herbarium sheets these specimens were pressed, mounted. The same were recognized from various Floras (Rahmatullah *et al.*, 2010). The determined voucher specimens are deposited in the herbarium and were identified from

literature and PMNH (Pakistan Museum of Natural History). Local herders were interviewed to get local names of the plants and provided.

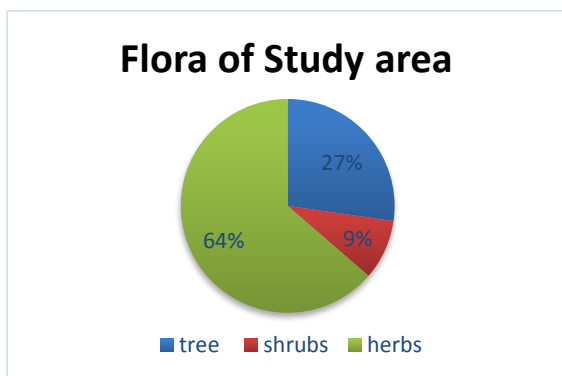
#### Results and discussion

Overall 33 plant species were identified which belonged to 24 families. Of those, 9 species of tree, 21 species of herbs and 3 species of shrubs were identified and recorded (Table 1 and Fig. 1). The 9 tree species belonging to 6 families were identified out of which, the two families Tamaricaceae and Moraceae contributed 2 species and rest of families Meliaceae, Myrtaceae, Salicaceae and Fabaceae contributed one species each as shown as in Fig. 2. Total 21 herbs species belonging from 14 families were identified, out of which 3 species from family Asteraceae and Euphorbiaceae, 2 species from family Poaceae, Amaranthaceae and Polygonaceae, 1 species from each family which are Cyperaceae, Cannabaceae, Zygophyllaceae, Pteridaceae, Boraginaceae, Oxalidaceae, Apocynaceae and Potamogetonaceae (Fig. 3.). Three shrubs species were identified from studied area, 1 species from family Typhaceae and 2 species from family Verbenaceae.

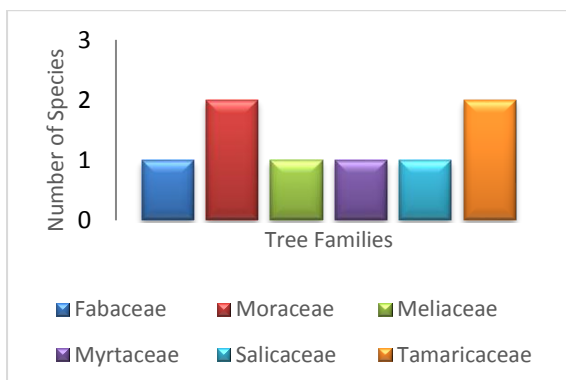
**Table 1.** Flora of bela forest of Indus between Tarbela and Khairabad encountered during study from July 2015 to June 2016.

S. No	Common name	Scientific name	Family
<b>Tree Species:</b>			
1	Sheesham	<i>Dilbergia sissoo</i>	Fabaceae
2	Babul	<i>Acacia nilotica</i>	Fabaceae
3	Wild Fig	<i>ficus palmate</i>	Moraceae
4	Chinaberry	<i>Melia azedarach</i>	Meliaceae
5	White mulberry	<i>Morus alba</i>	Moraceae
6	Gond	<i>Eucalyptus camaldulensis</i>	Myrtaceae
7	Indian willow	<i>Salix tetrasperma</i> ,	Salicaceae
8	Khagal	<i>Tamarix dioica</i>	Tamaricaceae
9	Athel tree	<i>Tamarix aphylla</i>	Tamaricaceae
<b>Herbs Species:</b>			
10	Doodi Buit	<i>Euphorbia prostrata</i>	Euphorbiaceae
11	Kans grass	<i>Saccharum spontaneurn</i>	Poaceae
12	Marijuana	<i>Cannabis sativa</i>	Cannabaceae
13	Cockle-bur	<i>Xanthium strumarium</i>	Asteraceae
14	Lyngbye's sedge	<i>Carex fedia</i>	Cyperaceae
15	Horned pondweed	<i>Zannichellia palustris</i>	Potamogetonaceae
16	Burrageokharu	<i>Tribulus terrestris</i> .	Zygophyllaceae
17	devil's horsewhip	<i>Achyranthes aspera</i>	Amaranthaceae

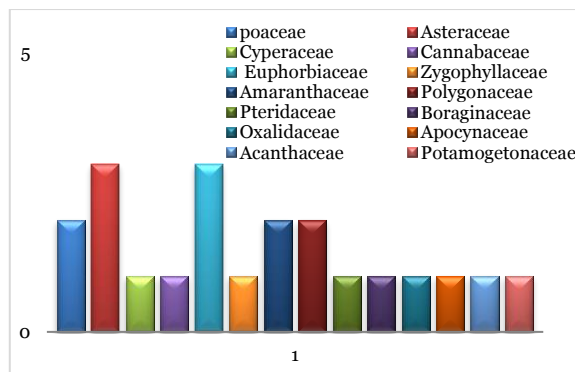
S. No	Common name	Scientific name	Family
18	slender amaranth	<i>Amaranthus viridis</i>	Amaranthaceae
19	white-top weed	<i>Parthenium Hysterophorus</i>	Asteraceae
20	Knotweed	<i>Polygonum plebeium</i>	Polygonaceae
21	Common maidenhair	<i>Adiantum capillus-veneris</i>	Pteridaceae
22	Safed bhanga	<i>Heliotropium strigosum</i>	Boraginaceae
23	wall barley	<i>Hordeum murinum</i>	Poaceae
24	procumbent yellow-sorrel	<i>Oxalis caniculata</i>	Oxalidaceae
25	Garden spurge	<i>Euphorbia hirta</i>	Euphorbiaceae
26	cat's milk	<i>Euphorbia helioscopia</i>	Euphorbiaceae
27	Rubber bush	<i>Calotro pisprocera</i>	Apocynaceae
28	Malabar nut	<i>Justicia adhatoda</i>	Acanthaceae
29	Toothed dock	<i>Rumex dentatus</i>	Polygonaceae
30	woolly distaff thistle	<i>Carthamus Lanatus</i>	Asteraceae
<b>Shrubs Species:</b>			
31	Lesser Indian reed mace	<i>Typha angustata</i>	Typhaceae
32	common vervain	<i>Verbena officinalis</i>	Verbenaceae
33	West Indian lantana	<i>Lantana camara</i>	Verbenaceae



**Fig. 1.** Distribution of flora (percentage) of bela forest of Indus between Tarbela and khairabad encountered during study from July 2015 to June 2016.



**Fig. 2.** Number of plant species in each family in bela forest study area, encountered during study from July 2015 to June 2016.

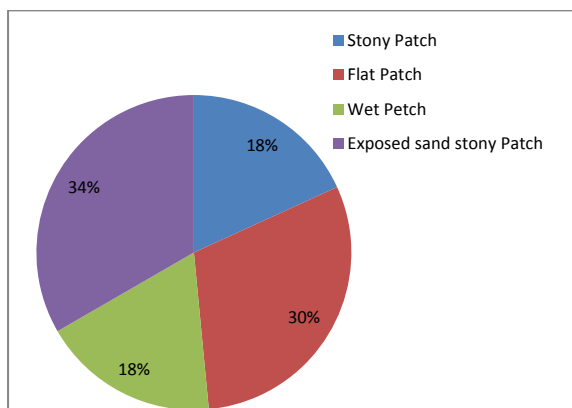


**Fig. 3.** Number of herbs species in each family in bela forest study area, encountered during study from July 2015 to June 2016.

The herbs were found as the dominant in the flora of Indus between Tarbela and Khairabad (64%), followed by trees species (27%) and least species recorded were shrubs with a percentage of 9. Among the herbs, Euphorbiaceae and Asteraceae families were seen dominant, while Poaceae, Amaranthaceae and Polygonaceae families were recorded as co-dominant and Cyperaceae, Cannabaceae, Zygophyllaceae, Pteridaceae, Boraginaceae, Oxalidaceae, Apocynaceae and Potamogetonaceae were equally distributed families. Among the trees, the Moraceae and Tamaricaceae families were seen as dominant, while the Meliaceae, Myrtaceae, Salicaceae and Fabaceae were equally distributed families. Among the shrubs, the Verbenaceae family was seen as dominant while the Typhaceae Family was equally distributed. The families like Fabaceae, Myrtaceae, Tamaricaceae, Poaceae, Cannabaceae and Asteraceae were found most common throughout the study area while the families like Moraceae, Meliaceae, Tamaricaceae, Polygonaceae, and Verbenaceae were recorded as abundant families. The plants species like *Salix tetrasperma*, *Carex fedia*, and *Rumex dentatus* were found rarely. The unknown species like *Oxalis caniculata*, *Heliotropium strigosum*, *Saccharum spontaneum*, *Cannabis sativa*, *Xanthium strumarium*, *Typha angustata*, *Carex fedia*, *Zannichellia palustris*, *Tribulus terrestris*, *Achyranthes aspera*, *Amaranthus viridis*, *Parthenium Hysterophorus*, *Polygonum plebeium*, *Verbena officinalis*, *Lantana camara*, *Carex fedia*, and *Rumex dentatus* were taken to the Pakistan Museum of Natural History (PMNH), Islamabad for proper identification and classification.

**Table 2.** Distribution of Flora on various sites in study research area.

S.No	Stony Patch	Flat Patch	Wet Patch	Exposed Sand Stone Patch
1	<i>Dilbergia sissoo</i>	<i>Verbena officinalis</i>	<i>Typha angustata</i>	<i>Lantana camara</i>
2	<i>Euphorbia prostrata</i>	<i>Tribulus terrestris</i>	<i>Carex fedia</i>	<i>Cannabis sativa</i>
3	<i>Saccharum spontaneum</i>	<i>Achyranthes aspera</i>	<i>Zannichellia palustris</i>	<i>Xanthium strumarium</i>
4	<i>Polygonum plebeium</i>	<i>Amaranthus viridis</i>	<i>Adiantum capillus-veneris</i>	<i>Parthenium hysterophorus</i>
5	<i>Oxalis caniculata</i>	<i>Hordeum murinum</i>	<i>Salix tetrasperma</i>	<i>Heliotropium strigosum</i>
6	<i>Euphorbia helioscopia</i>	<i>Justicia adhatoda</i>	<i>Tamarix dioica</i>	<i>Euphorbia hirta</i>
7		<i>Ficus palmate</i>		<i>Calotro pispocera</i>
8		<i>Melia azedarach</i>		<i>Rumex dentatus</i>
9		<i>Morus alba</i>		<i>Carthamus Lanatus</i>
10		<i>Tamarix aphylla</i>		<i>Acacia nilotica</i>
11				<i>Eucalyptus camaldulensis</i>

**Fig. 4.** Distribution of Flora (percentage) on various sites of bela forest of Indus between Tarbela and Khairabad encountered during study from July 2015 to June 2016.

The distribution of the flora (Table 2) in the study area was correlated with four different sites in the study area from Tarbela to Khairabad. It was found out that majority of the of plant 34% was present on exposed sand stone patch, followed by vegetation (30%) on Flat Patches and the lowest (18%) percentage of flora was recorded on both stony and wet patches. The most vegetated site (exposed sand stone patch) was due to raised patch providing ample and conserved space for plants like *Dilbergia sissoo*, *Euphorbia prostrata*, *Saccharum spontaneum*. The least vegetated site (Wet and Stony patches) was due to frequent flooding (Inundation) and washing away of the fertile soil due to occurrence of heavy

current. Besides, the site was frequently visited by herds of local graziers and nomads. *Ficus palmate*, *Melia azedarach*, *Morus alba* and *Tamarix aphylla* were found in flat patches with conditions not found in wet and stony patches as well as in exposed sand stone patches. The distribution of flora recorded at various sites in the study area has been shown in Fig. 4.

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