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Riparian Floral Diversity of Ganga River

GRBMP : Ganga River Basin Management Plan

by

Indian Institutes of Technology

IIT Bombay | IIT Delhi | IIT Guwahati | IIT Kanpur | IIT Kharagpur | IIT Madras | IIT Roorkee

Preface

In exercise of the powers conferred by sub-sections (1) and (3) of Section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government has constituted National Ganga River Basin Authority (NGRBA) as a planning, financing, monitoring and coordinating authority for strengthening the collective efforts of the Central and State Government for effective abatement of pollution and conservation of the river Ganga. One of the important functions of the NGRBA is to prepare and implement a Ganga River Basin: Environment Management Plan (GRB EMP).

A Consortium of 7 Indian Institute of Technology (IIT) has been given the responsibility of preparing Ganga River Basin: Environment Management Plan (GRB EMP) by the Ministry of Environment and Forests (MoEF), GOI, New Delhi. Memorandum of Agreement (MoA) has been signed between 7 IITs (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and MoEF for this purpose on July 6, 2010.

This report is one of the many reports prepared by IITs to describe the strategy, information, methodology, analysis and suggestions and recommendations in developing Ganga River Basin: Environment Management Plan (GRB EMP). The overall Frame Work for documentation of GRB EMP and Indexing of Reports is presented on the inside cover page.

There are two aspects to the development of GRB EMP. Dedicated people spent hours discussing concerns, issues and potential solutions to problems. This dedication leads to the preparation of reports that hope to articulate the outcome of the dialog in a way that is useful. Many people contributed to the preparation of this report directly or indirectly. This report is therefore truly a collective effort that reflects the cooperation of many, particularly those who are members of the IIT Team. Lists of persons who are members of the concerned thematic groups and those who have taken lead in preparing this report are given on the reverse side.

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1. Introduction

The river Ganga, life line for millions of people is aptly called the "River of India". This river is the most widely written about and worshipped of all the renowned rivers throughout the world. Although, ~~by~~ a number of rivers feature in the civilization in pre-history and ancient history; Ganga is the most sacred, mythical and reverred. It is symbol of our traditions and values, providing physical and spiritual nourishment to millions of devotees. There are extensive classical and folk literatures related to this heavenly river known by many as "Divine river or Devnadi" (Kumar, 2001). It is the largest and most important water shed of India covering 1,28,411 sq km as shown in Figure 1, The main features are mentioned in Table 1.

Table 1: The main features of Ganga basin (Kumar, 2001)

S.No	Features	Measurements
1.	Total geographical area and annual discharge	8,61,404 sq km; 4,59,040 million cubic meters
2.	Surface water availability	446 million acre feet (MAF)
3.	Irrigation potential	27,350 thousand hectares
4.	Hydel potential	11,579 mega watts (at 60% load factor)
5.	Average annual rainfall	364 cm (Total)
6.	Sediment load	2.4 billion metric tons per year
7.	Temperature gradients	10-40 $^{\circ}$C

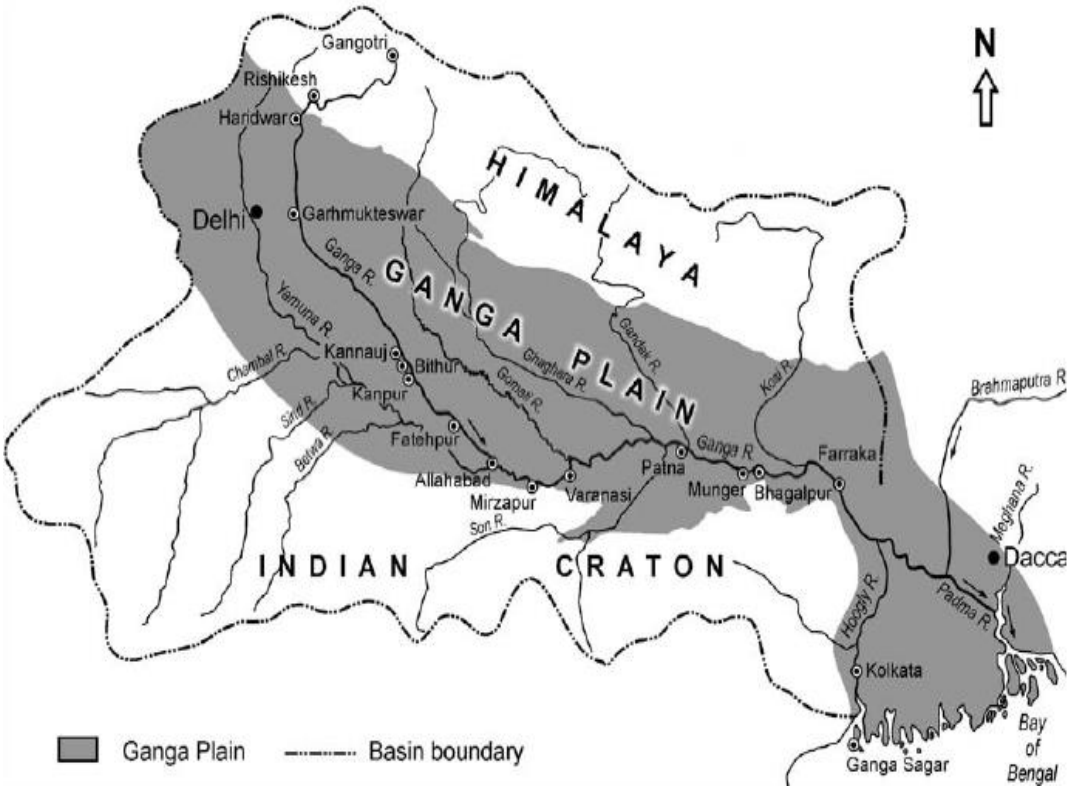

Figure 1: Ganga plain in India

1.1. The riparian flora of Ganga basin

River bank vegetation is ecologically termed as riparian flora, and is highly dynamic. It links terrestrial and aquatic habitat, under the influence of waterways such as rivulet banks or riverbanks, is represented by a particular type of vegetation that grows along the sides of rivers, which are called the river's riparian zone (Dutta *et al*., 2011). Riparian plant habitats and communities are characterized by hydrophilic plants (Figure 2). Riparian vegetation consists of macrophytes, native grasses, sedges, climbers, shrubs and trees (Dutta *et al.*, 2011). Riparian zones are significant in ecology and environmental management, because of their role in soil conservation, their habitat biodiversity, and the influence they have on fauna and aquatic ecosystems, including grassland, woodland, wetland or even non-vegetative. Buffer strips of riparian vegetation are effective in reducing sediment and nutrient loads (Groffman *et al*., 1990; Castelle *et al.,* 1994). In the Himalayan region, riparian forests play a pivotal role in the life of people, to fulfil their daily requirements like timber, fuel, fodder, medicine, fruits and other purposes (Shyam, 2008). Water current plays a decisive role in dispersal of vegetative propagates and in influencing the marginal vegetation. After the floods, new and more fertile lands emerge, containing sprout luxuriant herbaceous vegetation. Some of these plants are ecologically very important as they provide shelter to the aquatic animals for breeding and spawning (Bilgrami, 1991).

Figure 2: Riparian flora of Ganga river near Haridwar

There is no systematic account available for plant diversity along the entire stretch of Ganga. The first written account of journey to Gangotri dates back to 1820 by Fraser. Subsequently, Pallis (1934), Auden (1941), Sahai (1953), Gupta (1960), Bhattacharyya and Goel (1982), Groffman *et al.* (1990), Krishanmurti (1991), Castelle *et al. (*1994), Shyam (2008), Gangwar and Joshi (2006) and Gangwar and Gangwar (2011) explored the Ganga river biodiversity. In this report effort has been made to compile the scattered data available on riparian floral diversity.

Total 475 riparian species have been documented in book "*THE GANGA–A SCIENTIFIC STUDY*", edited by Krishanmurti (1991) from Rishikesh to Chinasura. Some of the represented riparian flora is presented in **Annexure-I.** Out of 49 types of trees 16 have medicinal value. Total climbers reported were 28 of which 9 have medicinal value. Shrubs have total taxa of 55 with 15 being used for medicinal purposes. Herbs have the highest number of 317 in which 13 are medicinal herbs. Grasses and sedges have 17 and 9 species, respectively (Figure 3 and 4).

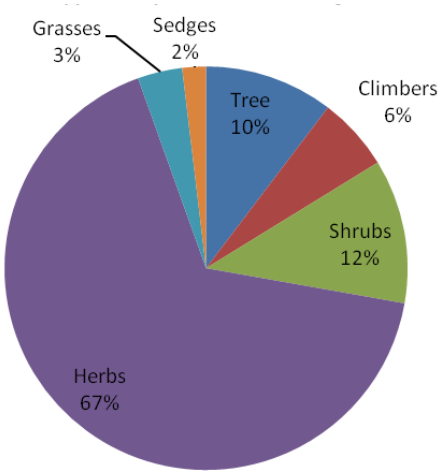

Figure 3: Riparian flora along Ganga river

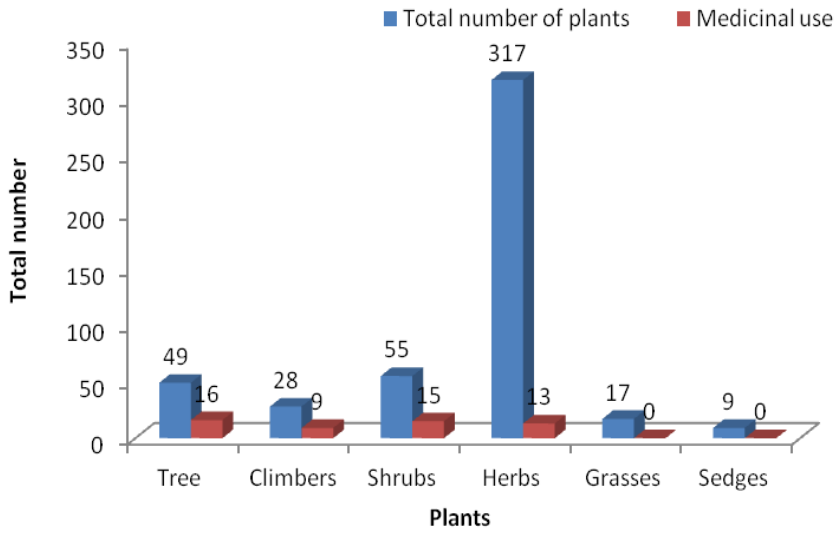

Figure 4: Medicinal use of riparian flora of Ganga river

1.2. Forest cover in Ganga Basin area

In the states like Haryana, Delhi, Bihar, Uttar Pradesh and Rajasthan, the forest cover is as low as 3.61 to 11.94% of the geographical area. Most of forest tracts within the Ganga basin are severely degraded on account of over exploitation. As a result, the forest ecosystem in the Ganga basin is under severe stress. Even in the states of Uttarakhand (45.8%), Madhya Pradesh (25.21%), Himachal Pradesh (26.35%) and West Bengal (14.64%) where the forest cover is higher, the proportion of the land under dense tree cover is very low due to extensive clear felling of trees carried out in recent decades. The state-wise forest cover in Ganga basin is shown in Table 2 and 3.

Table 2: State-wise forest cover in Ganga basin (Source: Environmental and Social Management Framework, NGRBP, 2011)

State	Geographical area (Sq km)	Forest				Geographical area (%)
		Very dense forest (Sq km)	Moderatly dense forest cover (Sq km)	Open forest (Sq km)	Total (Sq km)	
Bihar	94,163	231	3,248	3,325	6,804	7.23
Delhi	1,483	7	50	120	177	11.94
Haryana	44,212	27	463	1,104	1,594	3.61
Himachal Pradesh	55,673	3,224	6,383	5,061	14,668	26.35
Jharkhand	79,714	2,590	9,899	10,405	22,894	28.72
Madhya Pradesh	3,08,245	6,647	35,007	36,046	77,700	25.21
Rajasthan	3,42,239	72	4,450	11,514	16,036	4.69
Uttar Pradesh	2,40,928	1,626	4,563	8,152	14,341	5.95
Uttarakhand	53,483	4,762	14,165	5,568	24,495	45.80
West Bengal	88,752	2,987	4,644	5,363	12,994	14.64
Ganga Basin States	**1,308,892**	**22,173**	**82,872**	**86,658**	**1,91,703**	**14.65**
India	**3,287,263**	**83,510**	**3,19,012**	**2,88,377**	**6,90,899**	**21.02**

Table 3: Extent of forest cover in Ganges basin (Source: Forest Survey of India, 1995)

Catchment area	Dense forest	Open forest	Mangrove	Total	Scrub	Non-Forest	Grand total
Ganga Basin	63,011	47,682	2,119	1,12,812	9,898	7,28,965	8,51,675
% of Basin Area	7.40	5.60	0.25	13.25	1.16	85.60	100.00

1.3. Riparian flora in the stretches of the Ganga river

Riparian flora of the Ganga has been reported into three main stretches:

- Gangotri to Narora stretch
- Mirzapur to Farakka stretch
- Berhampur to Gangasagar stretch

1.4. Riparian flora in the Gangotri to Narora stretch

The upper Ganga basin spreads through two Indian states *viz*. Uttarakhand and Uttar Pradesh. This area includes four important towns *viz*. Rishkesh, Haridwar, Garhmukteshwar and Narora.

The main vegetation in the catchment area of Bhagirathi River in the upper stretch comprise of *Primula floribunda*, *Stellaria webbiana, Elatostema sessile* and *Geranium rotundifolium*. The shrubs like *Betula utilis, Rhododendron communis, R. anthopogon, Juniperus wallichiana* and *Salix flabellaris* are found growing near Bhojbasa (3794 m) among which *Betula utilis* being dominant (Kumar, 2001). *Cedrus deodara* borders the bed on both the sides of river on the flood plain deposit. *Pinus wallichiana* starts from near Jhala (Gupta, 1960). Between Gangotri to Haridwar 276 riparian plant species belonging to 82 families and 225 genera have been identified and documented (Figure 5), of which 56.16% species have medicinal value. Some of the important families are represented in Figure 6. Poaceae having 19 species reported to be the dominant family followed by Asteraceae, Euphorbiaceae, Moraceae, Malvaceae, Lamiaceae, Mimosaceae, Papilionaceae, Convolvulaceae and Urticaceae (Gangwar and Gangwar, 2011).

A taxonomic and economic characteristic of riparian floral diversity along river Ganga between Gangotri to Haridwar is listed in **Annexure-II** (Gangwar and Gangwar, 2011; Gangwar and Joshi, 2006). Gangwar and Gangwar (2011) also recorded dominant and rare flora along the Bhagirathi-Ganga at various sites between Gangotri to Haridwar during 2005-2007 (**Annexure-III).**

THDC Report (2009) on enviromental studies for Vishnugad Pipalkoti Hydro electric project submitted the name of important riparian plants species along the Alaknanda river and its tributaries as shown in Table 4.

Table 4: Riparian vegetation along the Alaknanda river and its tributaries (THDC Report, 2009)

Name of the riparian plant species	
*Acorus calamus**	*Nasturtium officinalis*
Aeginetia indica	*Phragmites kakara*
Ageratum conzoides	*Phyla nudiflora*
Anagallis arvensis	*Polygonum numbenus*
Artemisia nilagarica	*Potentilla sundarica*
Bistortia vacenifolia	*Ranunculus scleratus*
Cirsium arvense	*Rumex hastatus*
Cypres iria	*Saccharum arundinaceum*
C. rotundus	*Sorghum miliaceum*
Drymasia cordata	*Stellaria media*
Eclipta prostrate	*Stephmia eligans*
Eupatorium adscendensce	*Urtica dioica*
Mazus pumilus	*Viola canescens**

** Conservation status: Rare*

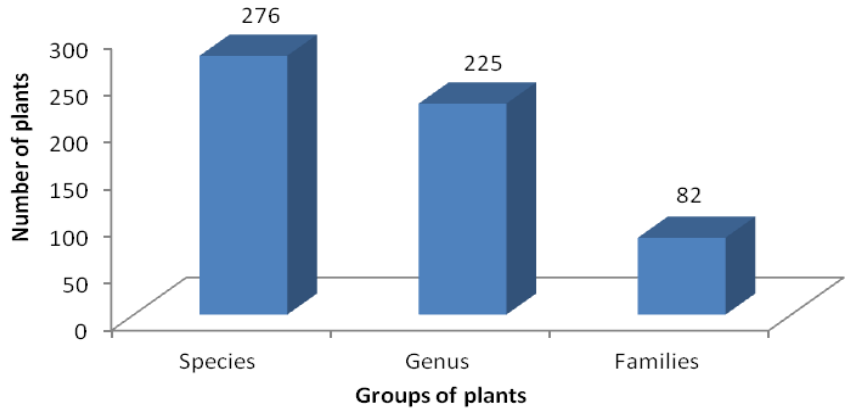

Figure 5: Riparian flora diversity of Ganga from Gangotri to Haridwar (Gangwar and Gangwar, 2011)

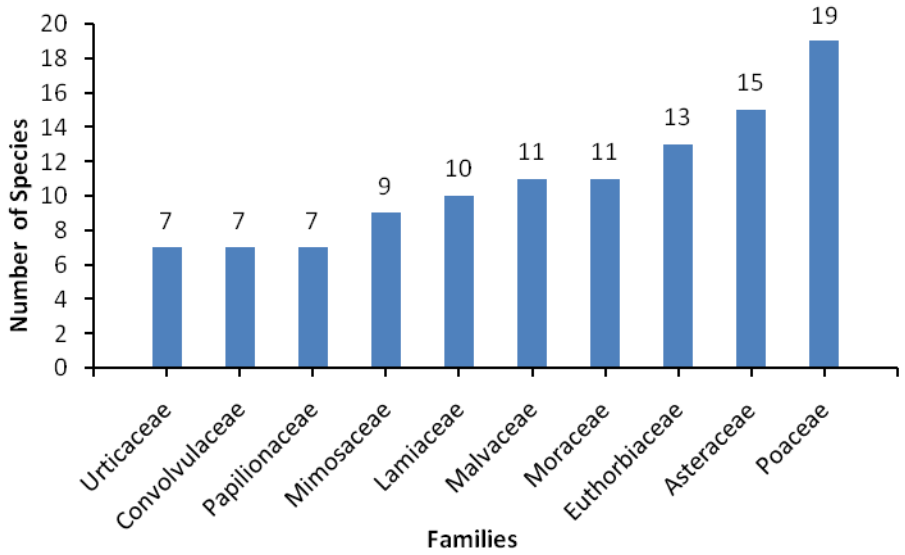

Figure 6: Families wise distribution of riparian flora from Gangotri to Haridwar (Gangwar and Gangwar, 2011)

1.5. Riparian flora of middle stretch between Mirzapur to Farakka

The middle Ganga basin spreads through three Indian states *viz*. Uttar Pradesh, Bihar and West Bengal. This area includes five important towns *viz*. Varanasi, Buxar, Patna, Bhagalpur and Farakka. This region has seven major tributaries, five of which are of Himalayan origin (Gomti, Ghaghara, Gandak, Burhi Gandak and Kosi), and two rivers originate from the heartland of India.

Uttar Pradesh: Important rivers in this stretch are mainly Ganga, Ramganga, Ghaghara, Yamuna and Gomti. Siddiqui (1991) gave an account of 40 riparian macrophytes from Narora-Kannauj region of which species of *Ammania*, *Eclipta, Polygonum, Ipomoea, Rumex, Saccharum, Scirpus* and *Tamarix* are amphibious in nature. The vegetation of Mirzapur-Ballia region was studied by Tripathi (1991) who reported total 36 macrophytes in which some species like *Ruellia prostrata, Amaranthus spinosus, Calotropis procera* and *Polygonum*

plebeium were present along the bank of river (Table 5). Canopy cover is formed by the trees, Saal (*Shorea robusta*), Teak (*Tectona grandis*), Sheesham (*Dalbergia sissoo)*, Mango (*Magnifera indica*), Neem (*Tamarindus indica*), Banyan (*Ficus* sp.), Peepal (*Ficus religiosa*), Jamun (*Syzygium cumini*), Mahua (*Madhuca longifolia*) and Semal (*Bombax ceiba*).

Table 5: Riparian macrophytes in Mirzapur-Ballia stretch (Tripathi, 1991)

Family	Species
Acanthaceae	*Ruellia prostrata*
Amaranthaceae	*Achyranthes aspera, Amaranthus spinosus, Chenopodium album*
Asclepiadaceae	*Calotropis procera*
Asteraceae	*Ageratum conyzoides, Eclipta alba, E. Prostrara, Grangea madersapatana, Launaea asplenifolia*, *Tridax procumbens, Xanthium strumarium*
Boraginaceae	*Heliotropium indicum*
Caesalpiniaceae	*Cassia occidentalis, C. Tora*
Convolvulaceae	*Convolvulus arvensis, C. microphyllus, Evolvulus alsinoides*
Euphorbiaceae	*Croton bonplandianum, C. sparciflorus, Euphorbia hirta, E. thymifolia, Ricinus communis*
Papaveraceae	*Argemone Mexicana*
Fabaceae	*Alhagi pseudalhagi, Crotalaria medicaginea*, *Desmodium triflorum, Melilotus indica*
Poaceae	*Cynodon dactylon, Dichanthium annulatum*, *Saccharum munja, S. spontaneum*
Polygonaceae	*Rumex dentatus, Polygonum plebeium*
Ranunculaceae	*Ranunculus scleratum*
Verbenaceae	*Phyla nodiflora*

Bihar: The main tributaries of Ganga in this region are Kosi, Gandak, Son and Burhi Gandak. Earlier workers have reported from Buxar to Barh, the presence of 7 shrubs, 41 herbs, 6 grasses and 2 sedges, besides these a number of tree species along the banks of river during 1987-88 (Kumar, 2001). The canopy is mainly composed of *Shorea robusta, Diospyros melanoxylon, Boswellia serrata, Terminalia tomentosa, Terminalia bellayoica, Terminalia arjuna, Pterocarpus marsupium, Madhuca indica, Justicia peploides, Rungia pectinata, Achyranthes aspera* and *Ipomoea aquatica* (Kumar, 2001). Bilgrami (1991) during the study on impact of flood on productivity of Diara land and vegetation reported 23 families comprising of 48 species in Diara land of Ganga amd its tributaries in Bihar (Table 6). The important species of this land were *Justicia peploides, Rauwolfia serpentine, Eclipta prostrate, Leucas aspera, Desmodium gangeticum, Lippia javanica* and *Scoparia dulcis* (Kumar, 2001).

Table 6: Vegetation of Diara Lands of Ganga and its tributaries in Bihar (Bilgrami, 1991)

Family	Species
Acanthaceae	*Justicia peploides, Rungia pectinata*
Polygonaceae	*Polygonum plebegum, Rumex dentatus*
Apocynaceae	*Rauwolfia serpentine, Calotropis gigantea*
Asteraceae	*Eclipta prostrata, Tridax procumbens*, *Vernonia cinerea*
Boraginaceae	*Heliotropium indicum*
Amaranthaceae	*Chenopodium album*
Cleomaceae	*Cleome viscose*
Convolvulaceae	*Ipomoea aquatic*
Cyperaceae	*Cyperus rotundus, Fimbristylis dichotoma, Kyllingia brevifolia, Scirpus maritimus*
Euphorbiaceae	*Acalypha indica, Croton bonplandianum, Phyllanthus simplex, Euphorbia hirta, E. Parviflora, Chrozophora rotleri*
Lamiaceae	*Leucas aspera*
Malvaceae	*Hibiscus abelmoschus, Sida cordata, S. obovata*
Nyctaginaceae	*Boerhavia diffusa*
Pedaliceae	*Pedalium murex*
Papaveraceae	*Argemone Mexicana*
Fabaceae	*Desmodium ganeticum, Lathyrus sativa, Indigofera* sp.*, Melilotus indica, Vicia sativus*
Poaceae	*Cynodon dactylon, Dicanthium annulatum, Digitara sanguinalis, Hygroryza aristata, Panicum repens, Saccharrum spontaneum, Setaria verticillata*
Portulaceae	*Portulaca quadrifolia*
Ranunculaceae	*Ranunculus scleratus*
Rubiaceae	*Oldenlandia corymbosa*
Scrophylariaceae	*Scoparia dulcis*
Tamaricaceae	*Tamarix dioica*
Verbenaceae	*Lippia javanica*

West Bengal: The climatic condition of this region is humid, subtropical, and tropical. Humidity is less near Farakka as compared to deltaic region of the state. Bilgrami (1991) ~~also~~ reported 212 macrophytes along the river Ganga in the region in Munger-Farakka (Table 7). Datta (1991) enumerated 32 species of macrophtes from Bally to Bandel (Table 8). The list included 7 species of Asteraceae, 4 species of Euphorbiaceae, 2 of Amaranthaceae and 3 of Cyperaceae, 2 of Polygonaceae and 1 of Poaceae. Some other important families are also showing its presence in the stretch. The canopy is mainly comprised of Semal (*Bombax ceiba),* Mango (*Magnifera indica*), Peepal (*Ficus religiosa*), Neem (*Tamarindus indica)*, Jackfruit (*Artocarpus heterophyllus*) and Pakur (*Ficus lacor*). Frequently inundated areas are covered with seedy grasses.

Table 7: Macrophytes along Ganga river Munger-Farakka stretch (Bilgrami, 1991)

Family	Species
Acanthaceae	*Adhatoda zeylanica, Barleria prionitis, B. cristata, Dipteracanthus prostratus, Hygrophila auriculata, Justicia peploides, J. simplex, Peristrophe bicalyculata, Rungia pectinata*
Acoraceae	*Acorus calamus*
Aizoaceae	*Trianthema portulacastrum*
Alismataceae	*Sagittaria guyanensis, S. sagittifolia*
Amaranthaceae	*Achyranthes aspera, Alternanthera pungens, A. sessilis, Amaranthus spinosus, A. viidis, Celosia argentea, Chenopodium album, Digera muricata, Gomphrena celosioides*
Anacardiaceae	*Mangifera indica*
Annonaceae	*Polyalthia suberosa*
Apiaceae	*Centella asiatica*
Apocynaceae	*Asdepias* sp., *Catharanthus roseus, Hemidesmus Indicus, Ichnocarpus frutescens, Rauvolfia serpentine*
Aponogetonaceae	*Aponogeton crispum, A. nantans*
Asclepiadaceae	*Calotropis procera, Leptadenia reticulate, Tylophora indica*
Asparagaceae	*Asparagus* spp.
Araceae	*Pistia stratiotes, Spirodela polyrhiza*
Asteraceae	*Artemisia* sp., *Ageratum conyzoides, Blainvillea acmella, Blumea mollis, Caesulia axillaris, Echinops echinatus, Eclipta prostrata, Erigeron asteroids, Grangea maderaspatana, Launea asplenifolia, Parthenium hysterophorus, Pulicaria crispa, Tridax procumbens, Vernonia anthelmintica, Vernonia cinera, Volutarella divaricata, Xanthium strumarium*
Bignoniaceae	*Oroxylum indicum, Stereospermum suaveolens*
Boraginaceae	*Cynoglossum lanceolatum,*
Brassicaceae	*Coronopus didymus, Nasturtuim indicum*
Cannabinaceae	*Cannabis sativa*
Caryphyllaceae	*Polycarpon prostratum*
Celastraceae	*Celastrus peniculatus*
Ceratophyllaceae	*Ceratophyllum demersum*
Cleomaceae	*Cleome gynandra, C. Viscosa*
Combretaceae	*Terminalia arjuna*
Commelinaceae	*Commelina benghalensis, C. nudiflora, Cyanotis axillaris, Murdannia nudiflora*
Convolvulaceae	*Convolvulus arvensis, C. microphylla, Cuscuta reflexa, Evolvulus alsinoides*
Costaceae	*Costus speciosus*
Cucurbitaceae	*Bryonopsis lanciniosa*
Cyperaceae	*Cyperus rotundus, Eleocharis dulcis, E. palustris, Fimbristylis dichotoma, Kyllinga brevifolia, Schoenoplectus articulatus, S. maritrimus*
Dioscoreaceae	*Dioscorea bulbifera*
Elatinaceae	*Bergia ammanioides*

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Family	Species
Euphorbiaceae	*Acalypha indica, Chrozophora rottleri, Croton bonplandianum, Emblica officinalis, Euphorbia thymifolia, Excoecaria agallocha, Jatropha gossypifolia, J. curcas, Mallotus repandusm, M. philipensis, Ricinus communis, Trewia nudiflora*
Fabaceae	*Alhagi pseudalhagi, Alysicarpus vaginalis, Cassia fistula, C. occidentalis, C. tora, Crotalaria medicaginea, Pongamia pinnata, Pueraria tuberosa, Desmodium gangeticum, D. triflorum, Psoralea corylifolia, Indigofera linnaei, I. linifolia, Lathyrus sativus, Medicago polymorpha, Melilotus alba, M. indica, Phaseolus trilobus, Uraria picta, Vicia sativa*
Fagaceae	*Quercus* spp.
Flacourtiaceae	*Casearia tomentosa, Flacourtia* sp.
Gentianaceae	*Canscora decussate*
Hydrocharitaceae	*Hydrilla verticillata, Ottelia alismoides, Vallisneria spiralis*
Hypericaceae	*Hypericum hirsutum*
Lamiaceae	*Anisomeles indica, Leonurus sibiricus, Leucas aspera, Nepeta hindostana, Ocimum canum, Salvia plebeian, Vitex negundo*
Lecythidaceae	*Barringtonia acutangula*
Lemnaceae	*Lemna paucicostata*
Lythraceae	*Ammannia baccifera*
Malvaceae	*Abelmoschus esculentus, Abutilon indicum, Hibiscus rosasinensis, H. vitifolius, Malvastrum coromandelianum, Sida acuta, S. cordata, S. cordifolia, S. Rhmbifolia*
Marsileaceae	*Marselia minuta*
Meliaceae	*Amoora rohituka, Azadirachta indica*
Menispermaceae	*Cissampelos pareira, Tinospora cordifolia*
Molluginaceae	*Glinus lotoides*
Moringaceae	*Moringa oleifera*
Myrtaceae	*Syzygium cumini*
Myrsinaceae	*Anagallis arvensis*
Najadaceae	*Najas graminea*
Nyctaginaceae	*Boerhavia diffusa*
Onagraceae	*Jussia repens*
Oxalidaceae	*Oxalis corniculata*
Papaveraceae	*Argemone mexicana*
Pedaliaceae	*Pedalium murex*
Phyllanthaceae	*Phyllanthus fraternus, P. simplex*
Plantaginaceae	*Scoparia dulcis*
Plumbaginaceae	*Plumbago zeylanica*
Poaceae	*Cynodon dactylon, Dichanthium annulatum, Imperata cylindrica, Panicum repens, Paspalum distichum, Setaria verticillata, Sacchanum spontaneum*
Polygonaceae	*Polygonum hydropiper, P. glabrum, P. plebium, Rumex dentatus*

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Family	Species
Pontederiaceae	*Eichhornia crassipes*
Portulacaceae	*Portulaca quadrifida, P. oleracea*
Potamogetonaceae	*Potamogeton crispus, P. nodosus, P. pectinatus, P. crispus, Zannichellia palustris*
Primulaceae	*Primula umbellate*
Rubiaceae	*Oldenlandia corymbosa, O. paniculata*
Ranunculaceae	*Ranunculus scleratus*
Rosaceae	*Potentilla supine*
Rutaceae	*Aegle marmelos*
Scrophulariaceae	*Lindernia crustacea, L. indica, Mazus pumilus, Mecardonia procumbens, Verbascum chinense*
Solanaceae	*Datura alba, D. metel, Nicotiana plumbaginifolia, Physalis minima, Solanum indicum, S. khasianum, S. surattense, S. erianthum, S. torvum, S. nigrum, Withania somnifera*
Tamaricaceae	*Tamarix dioica*
Typhaceae	*Typha nodiflora*
Verbenaceae	*Clerodendrum inerme, Lantana indica, L. camara, Lippia javanica, Phyla nodiflora*
Zygophyllaceae	*Tribulus terrestris*

Table 8: List of macrophytes (aquatic and semi aquatic) in Bally Bandel stretch (Datta, 1991)

Family	Species
Alismataceae	*Sagittaria sagittifolia*
Amaranthaceae	*Alternanthera philoxeoroides, Amaranthus spinosus*
Asteraceae	*Blumea lacera, Eclipta alba, Grangea maderaspatana, Tridax procumbens, Veronia cinerea, Xanthium strumarium, Wedelia calendulacea*
Boraginaceae	*Heliotropium indicum*
Brassicaceae	*Nasturtium indicum*
Chenopodiaceae	*Chenopodium indicum*
Cyperaceae	*Juncellus* sp., *Cyperus* sp., *Fimbristylis dichotoma*
Euphorbiaceae	*Chrozophora plicata, Croton bonpandianum, Phyllanthus niruri, Jatropha gossypifolia*
Lamiaceae	*Leonurus sibiricus*
Malvaceae	*Sida rhombifolia*
Molluginaceae	*Mollugo stricta*
Nyctaginaceae	*Boerhavia repens*
Papaveraceae	*Argemone mexicana*
Plantaginaceae	*Scoparia dulcis*
Poaceae	*Paspalum disticum*

Table continued to next page ... ...

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Family	Species
Polygonaceae	*Polygonum* sp.*, Rumex dentatus*
Pontederiaceae	*Eichhornia crassipes*
Typhaceae	*Typha* sp.
Verbenaceae	*Phyla nodiflora*

Stretch between Baharampur to Gangasagar:

Farakka to Nabadwip follows the freshwater flora pattern. After Nabadwip to Konnagar the habitat become nearly freshwater. From Konnagar estuarine zone start and this habitat ends up at Diamond Harbour. From Diamond Harbour marine zone start. Table 9 summarizes some of the plant species available in middle lower and lower Ganga region.

Table 9: Some of the plant species available in middle lower and lower Ganga region (Krishnamurti, 1991)

Botanical name	Family	Type	Common names	Economic value
Dicotyledons				
Clematis gouriana	Ranunculaceae	Shrub	Chhagalbati	Used as insecticides
Narvelia zeylanica	Ranunculaceae	Shrub	Chhagalbati	Food and medicinal
Nigella sativa	Ranunculaceae	Herb	Kalojira	Culinary and medicinal
Dillenia indica	Dilleniaceae	Tree	Chalta, Elephant apple	Food and medicine
Magnolia grandiflora	Magnoliaceae	Tree	Champa	Cosmetic and medicinal
Annona reticulata	Annonaceae	Tree	Nona	Food and medicinal
Annona squamosa	Annonaceae	Tree	Ata, Custard apple, Sugar apple	Food and medicinal
Artabotrys hexapetalus	Annonaceae	Shrub	Kantali Champa, kat champa	Ornamental and medicinal
Stephania japonica	Menispermaceae	Shrub	Nimusha	Medicinal
Cissampelos pareira	Menispermaceae	Shrub	Akanadi, Ekleja, Velvet leaf	Medicinal
Nelumbo nucifera	Nelumbonaceae	Herb	Padma, Kamal	
Monocotyledons				
Costus speciosus	Costaceae	Herb	Kust, Keu	Medicinal
Blyxa octandra	Hydrocharitaceae	Submerged herb	Pata syola	Used in aquarium
Hydrilla verticillata	Hydrocharitaceae	Submerged herb	Jhangi	Aquarium plant, food for fish
Vanda tessellata	Orchidaceae	Epiphytic	Rashna	Ornamental
Zeuxine strateumatica	Orchidaceae	Epiphytic	Swet huli	Ornamental
Curcuma amada	Zingiberaceae	Herb	Amada	Culinary
Curcuma aromatica	Zingiberaceae	Herb	Ban haldi	Cosmetic and medicinal

The mangroves are the dominant flora of this zone. The typical mangrove species include *Avicennia* spp., *Amoora cuculata, Bruguiera* spp., *Excoecaria agallocha, Heretiera fomes, Kandelia candel, Phoenix paludosa* and *Rhizophora apiculata.* Naskar and Guhabakshi (1987) reported true mangroves species. Out of these, 30 are trees, 20 shrubs and 20 herbs. Das (1991) listed all the true mangroves species of this zone as listed in Table 10.

Table 10: Family name and species of Mangrove from Sunderban delta (Das, 1991)

Family	Species
Acanthaceae	*Acanthus ilicifolius*
Arecaceae	*Phoenix paludosa, Nypa fruticans*
Acanthaceae	*Avicennia alba, A. marina, A. officinalis*
Caesalpiniaceae	*Cynomertra ramiflora*
Combretaceae	*Lumnitzera racemosa*
Euphorbiaceae	*Excoecaria agallocha, E. bicolor*
Lythraceae	*Sonneratia apetala, S. caseolaris*
Malvaceae	*Hibiscus tortussus, Thespesia lampus*
Meliaceae	*Amoora cucullata, Xylocarpus granatum, X. mulucensis*
Myrsinaceae	*Aegiceras corniculatum*
Plumbaginaceae	*Aegialitis rotundifolia*
Poaceae	*Porterisia coarctata*
Rhizophoraceae	*Bruguiera cylindrica, B. gymnorhiza, B. parviflora, B. sexangula, Kandelia candel, Rhizophora apiculata, R. mucronata*
Sterculiaceae	*Heritiera fomes*
Tiliaceae	*Brownlowia lanceolata*

1.6. Floristic diversity

A floristic study was carried out by Naskar (1993) as a part of database preparation of middle lower Ganga river basin based on the available secondary data. The available literature of this region is rather scanty. A total of 154 angiosperm families were recorded from this region. Out of this, 124 families belong to Dicotyledons and other 30 Monocotyledons (Figure 7, Table 11). Verma and Prakash (2010) reported 293 species and 49 genera of epilithic diatoms in this region.

Table 11: The statistics of the plants available in middle lower and lower Ganga River Basin

Class	Families	Genera	Trees	Shrubs	Herbs	Weeds	Terrestrial spp.	Cultivated spp.
Dicotyledons	124	531	229	261	384	623	692	251
Monocotyledons	30	149	6	19	276	263	140	38
Total Angiosperms	154	680	235	280	660	886	832	289

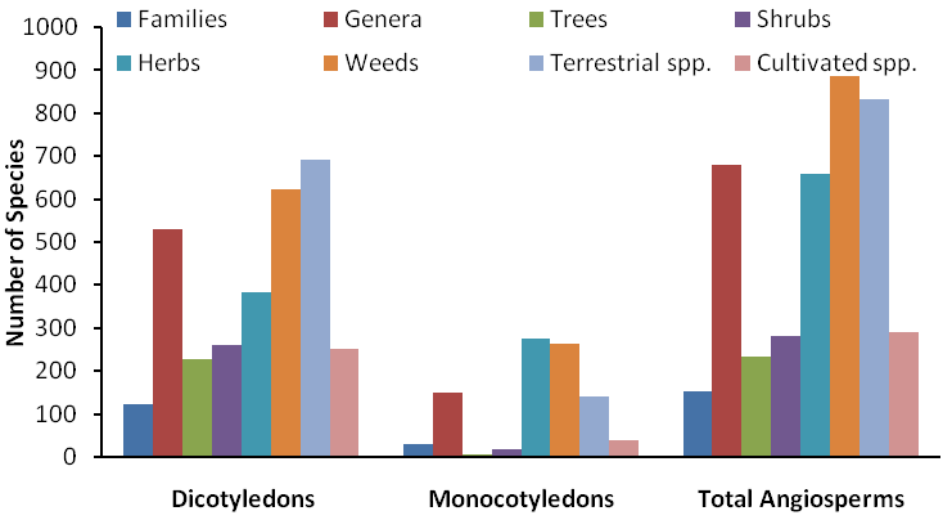

Figure 7: Account of total Angiosperms in the middle lower and lower Ganga river delta (Source: Plant Wealth of Ganga Delta, Naskar, 1993)

Status of the indigenous and exotic plants available in middle lower and lower Ganga river basin are shown below (Table 12 and Figure 8).

Table 12: Indigenous and exotic status of total Angiosperms in middle lower and lower Ganga river basin (Source: Plant Wealth of Ganga Delta, Naskar, 1993)

Class	No. of species	Indigenous sp.	Exotic sp.
Dicotyledons	874	616	258
Monocotyledons	301	245	56
Total Angiosperms	1175	861	314

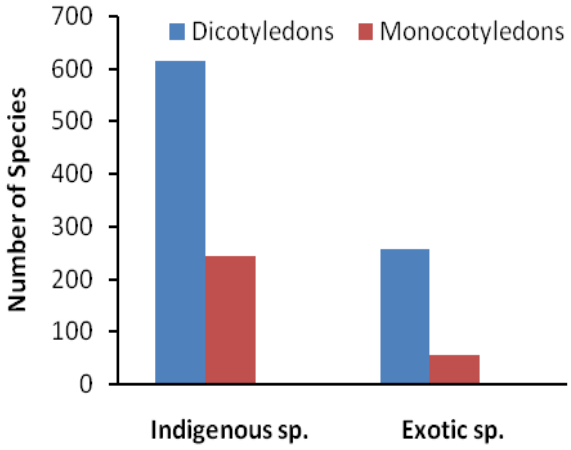

Figure 8: Indigenous and exotic status of Angiosperms of middle lower and lower Ganga basin

Studies done by Naskar (1993) showed 10 dominant angiosperm families of middle lower and lower Ganga river basin (Figure 9) while Gopal and Chauhan (2006) gave an account of rare, threatened and endangered flora of the Indian Sundarbans (Table 13).

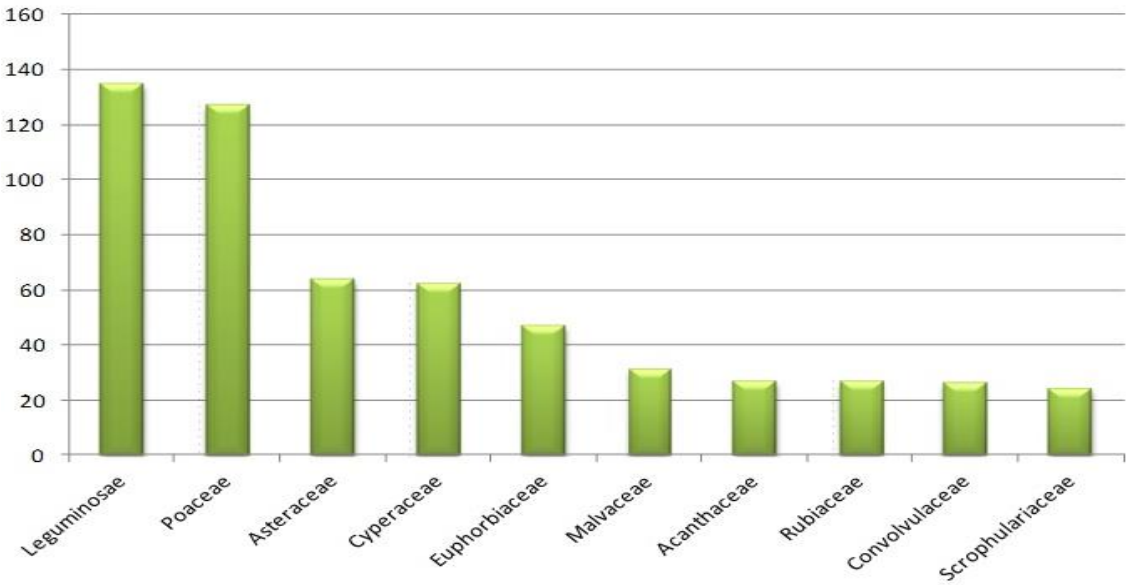

Figure 9: Dominant angiosperm families of middle lower and lower Ganga river basin

Table 13: Rare, threatened and endangered flora of the Indian Sundarbans (Gopal and Chauhan, 2006)

Family	Species	Status
Meliaceae	*Aglaia cucullata*	Rare
	Xylocarpus mekongensis	Threatened
	Xylocarpus granatum	Threatened
Rhizophoraceae	*Rhizophora apiculata*	Occasional
	Bruguiera parviflora	Occasional
	Ceriops decandra	Occasional
	Kandelia candel	Occasional
Sterculiaceae	*Heritiera fomes*	Threatened
Rubiaceae	*Scyphiphora hydrphyllacea*	Rare
	Hydrophylax maritima	Rare
Tiliaceae	*Brownlowia lanceolata*	Occasional
Arecaceae	*Nypa fruticans*	Occasional
Acanthaceae	*Acanthus volubilis*	Very Rare
Caesalpiniaceae	*Cynometra ramiflora*	Rare
Fabaceae	*Dalbergia spinosa*	Rare
Sapotaceae	*Manilkara hexandra*	Rare
Rutaceae	*Atalantia correa*	Very Rare

1.7. Effect of riparian flora on river Ganga

River bank health is a term used to illustrate the ecological condition of a river bank or riparian zone. Health is more than just the plants and animals that live in a river bank, and the role of plants in stabilizing the river banks and maintaining the river health. It depends on the diversity of habitats, plant and animal species, the effectiveness of linkages and the maintenance of ecological processes (Dutta *et al.,* 2011) as shown in Figure 10.

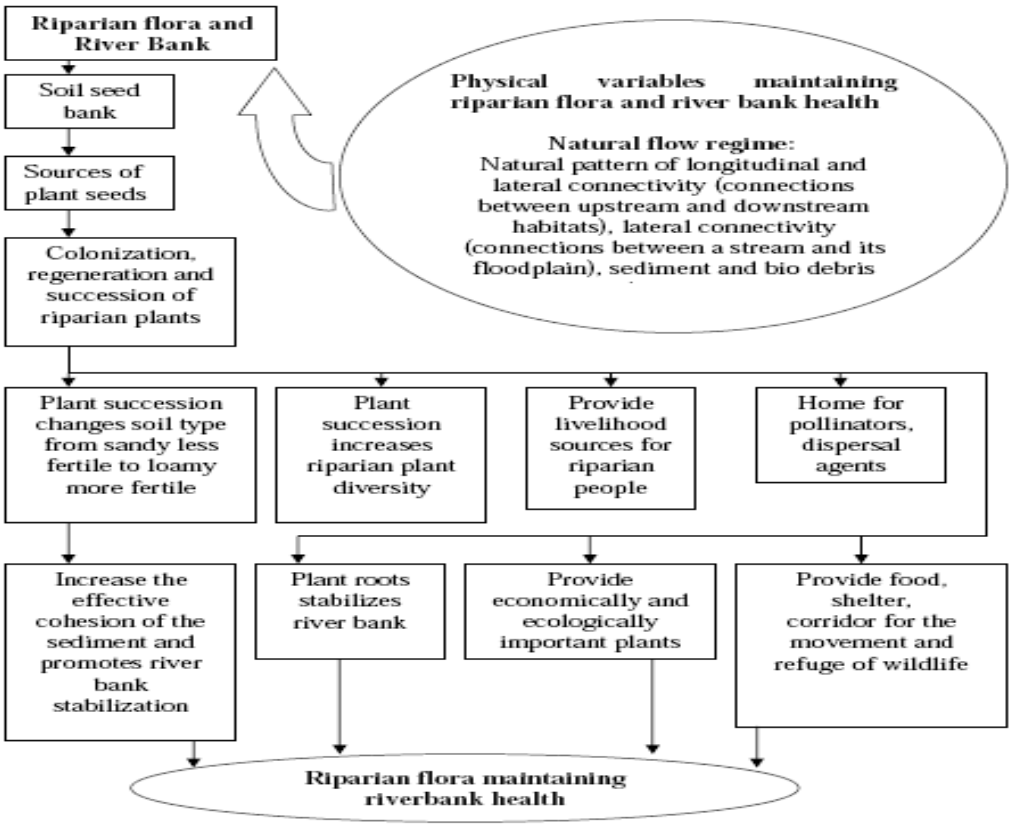

Figure 10: Schematic representation of maintenance and influence of riparian flora on the river bank health (Dutta *et al*., 2011)

Saccharum species exhibited the highest conservation value (CV) in checking erosion (Ambasht, 1970). *C. dactylon* reported by Gangwar and Gangwar (2011) at right bank of Ganga near Uttarkashi also have high soil conservation value. *Saccharum munja* and *Saccharum spontaneum* are also reported near Rishikesh and Shyampur (Gangwar and Gangwar, 2011). But these species were reported as rare at Ganga bank by Shyam (2008).

Native macrophytes and grasses on the river bank strips considerably check the erosion by binding soil and "roughness", that reduces stream flow rates in most downstream areas. Vegetation keeps banks drier by intercepting precipitation, transpiration, and increased drainage through soil (Dutta *et al.*, 2011). But very low diversity of grasses was recorded by Shyam (2008). *Saccharum spontaneum* and *Imperata cylindrica* grass species were found in very low density at Rishikesh and Shaympur station (Shyam, 2008).

Plant hydrochory is an important biological way of maintaining the riparian ecosystem health. Allochthonous inputs contained in the detritus collected by the floods also add nutrients (Dutta *et al.,* 2011).

Emblica officinalis, Dioscorea bulbifera, Leptadenia reticulata, Sida cordifolia and *Tribulus terrestris* etc. species are dwindling species of Ganga basin (Krishanmurti, 1991).

The biodiversity of mangroves has also been of increasingly greater interest, because the mangrove ecosystems are the most threatened ones by the global climate changes, particularly the sea level rise (Macintosh and Ashton, 2002, 2004). Mangroves are relatively well known for their floral diversity which is comprised of only 65-69 species of vascular plants which have several specific adaptations to the dynamic coastal environment (Kathiresan and Bingham, 2001).

The Indian part of the Sundarban with higher salinity supports sparse *Excoecaria agallocha*, a dense understory of *Ceriops*, and dense patches of the hantal palm (*Phoenix paludosa*) on drier soils. *Xylocarpus* sp. and *Bruguiera* sp. occur sporadically throughout the area. *Oryza coarctata*, *Nypa fruticans* and *Imperata cylindrica* are prevalent on mud flats (Khan, 1986). Large stands of *Sonneratia apetala* occur on newly accreted mud banks. Sand dunes bordering the sea are primarily colonized by grasses such as *Paspalum vaginatum, Panicum repens, Aeluropus lagopoides* and *Phragmites karka*, which are followed by *Sesuvium portulacastrum* and *Ipomoea pescaprae* (= *I. biloba*) which constitute the climax dune vegetation. *Salicornia brachiata, Hygrophyllus asiatica* and *Scirpus fruticans* occur occasionally (Hussain and Acharya, 1994).

The mean volume per hectare of the Sundari (*Heritiera fomes*) tree was 34.5 in 1959. The volume was reduced to 19.9 in 1983 and 17.8 in 1996. The decrease is blamed on their over exploitation, legally and illegally, because of their commercial value and subtle changes in the ecosystem. Most of the distributaries of the river Ganga on the Indian side have already silted up. Thus, increased levels of salinity, particularly during the dry season (low flow period) affect biodiversity, with the salinity-tolerant species gradually overtaking species dependent upon regular freshwater inputs. Many plant species like *Heritiera fomes, Nypa fruticans* and *Phoenix paludosa* were very abundant in the Sundarban 50 years ago, but recently they have declined relatively as the salinity has increased. As a long-term consequence *Heritiera* is being replaced by *Excoecaria*. Increased levels of salinity, particularly during the dry season (low flow period) affect biodiversity, with the salinity-tolerant species gradually overtaking species dependent upon regular freshwater inputs.

In general, the forest structure is becoming simpler and the average height of the trees is decreasing. *Heritiera fomes* (the most important timber species from which Sundarban derives its name), which is abundant on the Bangladesh side, is not common on the Indian side where it is considered endangered. *Nypa fruticans* also has a limited occurrence within the Indian Sundarban; it is rapidly disappearing because of extensive exploitation. Based on their present status, *Aegiceras corniculatum, Kandelia candel, Rhizophora* sp., *Sonneratia acida, Sonneratia apetala* and *Sonneratia caseolaris* also require conservation measures (Gopal, 2006).

1.8 Reason of riparian biodiversity degradation

The major causes of riparian biodiversity degradation are both natural and anthropogenic (Figure 11). Anthropogenic effects are a major concern including construction activities, expansion of agriculture land for food and grazing pressure (Figure 11 and 12).

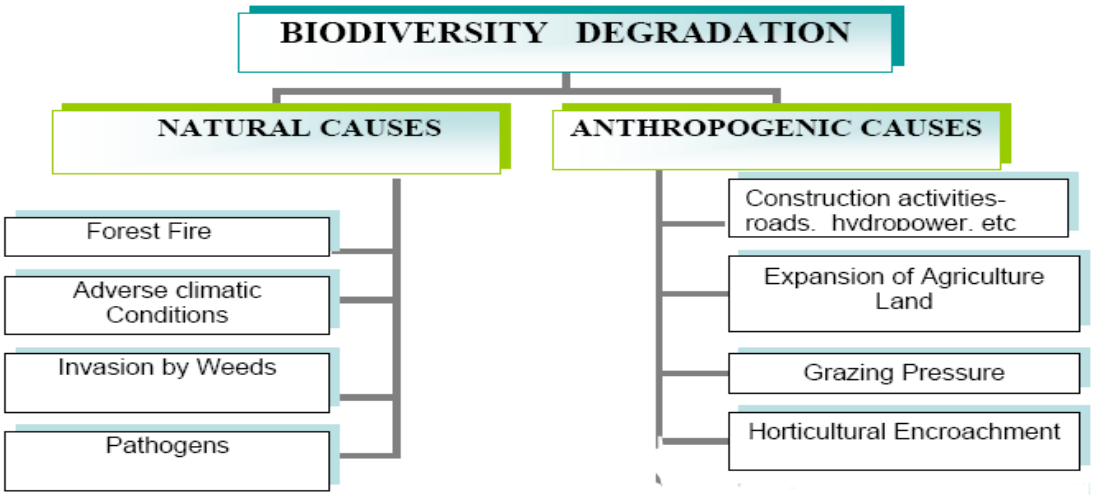

Figure 11: Riparian biodiversity degradation

Figure 12: Reason of biodiversity disruption (a) Due to forest fire (b) Construction activity

Thus major factors responsible for loss of biodiversity of mangrove have been depicted by Gopal (2006).

2. Strategies to conserve riparian biodiversity

Ecological restoration is the re-establishment of processes, functions, and related biological, chemical, and physical linkages between the aquatic and terrestrial ecosystems. Some conservation stretegies suggested are:

- To determine the root cause, which may be biological or non-biological, for the depletation of vegetation.
- To prepare an inventory of riparian flora through primary data collection and preserved through information retrieval system.
- To increase water flow as siltation is one of the major problems of the river. In some areas the river bed has risen so much (Dakshineswar, Naihati and Bandel) that in coming year the river itself may cease to exist. Therefore, more water flow is needed, which would save Ganga from being moribund, and it will reduce salinity level.
- To make awareness programme for conservation of plant resources at social level.
- Preserve Indigenous knowledge of ethenic people of that region regarding plants.
- Government should take the steps for reforestation and strong implementation of laws for the purpose of conservation.

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Annexure-I

Riparian Floral Diversity from Rishikesh to Chinasura (Krishnamurti et al., 1991)

Names of Plants	Ecoregions of Ganga River							Medicinal Importance
	1. Rishikesh to Garhmukteshwar	2. Kalakankar to Phaphamau	3. Mirzapur to Ballia	4. Buxar to Barh	5. Munger to Farakka	6. Bandel to Bally	7. Katwa to Chinasura	
Trees								
Acacia catechu	+					+		M
A. nilotica	+					+		
Aegle marmelos	+					+		M
Amoora rohituka	+					+		
Averrhoa carambola	+					-		
Azadirachta indica	+					+		M
Barringtonia acutangula	+					+		M
Buchanania lanzan	+					-		
Cassia fistula	+					+		M
Crataeva nervala	+					-		M
Emblica officinalis	+					+		M
Excoecaria agallocha						+		
Flacourtia sp.	+					+		
Gmelina arborea	+					-		M
Hibiscus tiliaceus						+		
Mangifera indica	+					+		
Mollotus philippensis						+		
Moringa oleifera	+					+		M
Oroxylum indicum						+		M
Pongamia pinnata	+					+		M
Quercus spp.	+					+		
Stereospermum suaveolens	+					+		
Syzygium cumini	+					+		M
Tamarix dioica						+		
Tecomella undulata	+					-		
Terminalia arjuna	+					+		M
T. bellirica	+					-		M
T. chebula	+					-		
Trewia nudiflora						+		
Vitex negundo	+					+		M

Climbers								
Asparagus spp.	+				+			M
Bryonopsis laciniosa	+				+			
Celastrus paniculatus					+			
Cissampelos pareira	+				+			M
Cuscuta reflexa		+			+			M
Dalbergia spinosa						+		
Derris trifoliate							+	
Dioscorea bulbifera	+				+			M
Hemidesmus indicus	+				+			M
Ichnocarpus fructescens	+				+			M
Ipomoea cairica							+	
I. sepiaria							+	
Leptadenia reticulate	+				+			
Mikania cordata							+	
Pueraria tuberose	+				+			M
Tinospora cordifolia	+				+			
Tylophora indica	+				+			M
Shrubs								
Abelmoschus esculentus	+				+			
Abutilon indicum				+	+			M
Acanthus ilicifolius							+	
Adhatoda zeylanica	+	+			+	+		M
Barleria spp.	+				+			
B. cristata						+		
B. prionitis	+	+			+		+	
Caesalpinia crista							+	
Casearia tomentosa						+		
Cassia occidentalis		+			+			M
C. sophera							+	M
Calotropis gigantean	+				+			M
C. procera		+	+		+			M
Clerodendrum inerme			+	+	+			M
Datura sp.			+	+	+			
Glycosmis arborea							+	
Hibiscus rosasinensis	+				+			
Jatropha curcus		+			+			M
J. gossypifolia					+	+	+	
Kirganelia reticulate							+	
Lantana camara			+	+	+			
L. indica		+			-			
Leonurus sibiricus						+		
Lippia javanica				+	+			
Mallotus repandus						+		
Polyalthia suberosa						+		
Plumbago zeylanica	+				+			M
Rouwolfia serpentina	+				+			M
Solanum khasianum	+				+			M

S. indicum	+				+			M
S. torvum	+				+			
S. erianthum	+				+			
Urena lobata							+	
Vernonia anthelmintica	+				+			M
Withania somnifera		+			+			M
Herbs								
Acalypha indica		+			+	+	+	
Achyranthes aspera	+	+	+	+	+			M
Ageratum conyzoides	+				+			M
Alhagi pseudoalhagi			+		+			
Alternanthera pungens		+			+	+	+	
Alternanthera sessilis		+		+	+			
Alternanthus spinosus							+	
Alysicurpus monilifer			+	+				
A. vaginalis		+						
Amaranthus spinosus		+			+			
A. spirtosus					+		+	
A. viridis		+		+	+			
Ammannia baccifera	+				+			
Anagallis arvenis		+			+			
Anisomeles indica		+			+			
Argemone mexicana		+	+	+	+			
Artemisia sp.	+							
Asclepias sp.	+							
Asphodelus tenuifolius		+	+	-	+			
Bergia ammannioides		+		+	+			
Blainvillea acmella		+	+		+			
Blumea amplectans		+						
Boerhavia diffusa	+	+	+	+	+			M
Caesulia axillaris				+	+			
Callicarpa nudiflora		+			+			
Cannabis sativa		+	+	+	+			
Canscora decussate		+			+			
Cassia tora			+		+			
Catharanthus roseus	+				+			M
Celosia argentea				+	+			
Centella asiatica	+				+			M
Chenopodium album		+	+	+	+	+	+	
Chrozosphora rottleri		+	+	+	+			
Chrysopogon aciculatus							+	
Cleome gynandra				+	+			
C. viscose				+	+			
Commelina bengalensis		+	+		+			
Convolvulus arvensis			+		+			
C. microphyllus			+		+			
Corchorus acutangulus			+	+				
C. didymus		+						
Costus speciosus	+				+			

Crotalaria medicaginea		+	+		+			
Croton bonplandianum		+		+	+			
Cyanotis axillaris			+	+	+			
Cynoglossum lancelatum	+				+			
Depteracanthus prostrates			+		+			
Desmodium gangeticum					+			M
D. trifolia		+		+	+			
Digera muricata		+			+			
Echinops echinatus		+			+			
Eclipta prostrate	+	+	+	+	+			M
Erigeron asteroids					+			
Euphorbia rosea				+				
E. thymifolia			+		+			
Evolvulus plumbaginifolia		+			+			
E. alsinoides				+	+			
Glinus lotoides	+				+			M
Gomphrena celosiodes		+			+			
Grangea maderasptana		+			+	+	+	
Heliotropium hirsutum				+	+			
H. indicum		+			+			
Hibiscus vitifolius					+			
Hydrolea zeylanica							+	
Hygrophila auriculata					+		+	
Indigofera linifolia	+	+			+			
I. linnaei	+	+			+			
Justicia peploides					+			
J. simplex		+						
Lathyrus sativus		+			+			
Launaea asplenifolia		+	+		+			
Leucas aspera		+			+			
Lindenbergia indica			+		+			
Lindernia crustacean		+	+		+			
Malva parviflora		+						
Malvastrum coromandelianum		+		+	+			
Mazus pumilus		+		+	+			
Mecardonia procumbens				+	+			
Medicago polymorpha		+			+			
Melilotus alba		+			+			
M. indica		+			+			
Murdannia nudiflora					+			
Nasturtium indicum					+	+	+	
Nepeta hindostana					+			
Nicotiana plumbaginifolia		+		+	+			
Ocimum canum		+			+			
O. sanctum					+			M
Oldenlandia corymbosa	+				+			M
Oldenlandia diffusa				+				
O. paniculata					+			
Oxalis comiculata			+	+				

Parthenium hysterophorus				+	+			
Pedalium murex					+			M
Peristrophe bicalyculata		+						
Phaseolus trilobus		+			+			
Phyla nodiflora					+	+	+	
Phyllanthus fratemus								
P. simplex				+	+			
Physalis minima		+			+			
Polycarpon prostratum		+	+					
Polygala erioptera		+						
Polygonum glabrum		+			+	+	+	
P. hydropiper					+	+	+	
P. orientale						+		
P. plebeium		+			+			
Portulaca oleracea				+	+			
P. quadrifida		+			+			
Potentilla supine	+				+			
Primula umbellata		+			+			
Psoralea corylifolia					+			M
Ranunculus sceleratus		+			+			
Ricinus communis			+		+			
Rumex dentatus		+	+	+	+			
Rungia pectnata		+	+	+	+			
Salvia plebeian		+		+	+			
Scirpus articulates					+			
Scoparia dulcis		+	+	+	+			
S. dulds							+	
Sida acuta			+	+				
S. cordata	+				+			M
S. cordifolia	+							M
S. obovata	+				+			
S. rhombiolia	+	+			+			
Solanum nigarum		+	+	+	+			
S. surattense	+				+			
Trianthema portulacastrum	+				+			
Tribulus terrestris	+	+			+			M
Tridax procumbens		+	+	+	+	+	+	
Ureria picta	+				+			M
Verascum chinense					+			
V. thaspus		+			+	+	+	
Vernonia cinerea		+			+	+	+	
Vicia sativa		+			+			
Volutarella divaricata				+	+			
Wedelia calendulacea						+	+	
Xanthium strumarium			+	+	+			
Grasses								
Cynodon dactylon			+	+	+		+	
Dichanthium annulatum				+	+			

Hygroryza aristata						+	+	
Imperata cylindrica					+			
Panicum repens				+	+			
Paspalum distichum				+	+			
Saccharum spontaneum				+	+			
Setaria verticillata				+	+			
Sedges								
Cyperus rotundus								M
Fimbristylis dichotoma					+	+		
Kyllinga brevifolia			+	+	+			
Scirpus articulates			+	+	+			
S. maritimus					+			

Annexure-II

Families, Botanical name, Common/Local name, Habit and Economic uses of riparian floral diversity along river Ganga between Gangotri to Haridwar (Gangwar and Gangwar, 2011; Gangwar and Joshi, 2006)

Families	Botanical Name and Common/ Local Name*	Habit	Economic Uses
Acanthaceae			
	Adhatoda zeylanica (Adusa)*	S	MD
	Barleria cristata (Saundi)*	H	MD
	Barleria prionitis (Peela-bansa)*	H	MD
	Rungia pectinata (Pindikunda)*	H	MD
Aceraceae			
	Acer cappadocicum (Kainchali)*	T	FL
Agavaceae			
	Agave americana (Rambans)*	S	MD
Amaranthaceae			
	Achyranthus aspera (Chirchita)*		
	Aerva lanata (Chaya)*	H	FD
	Alternanthera sissilis (Gudrisag)*	H	FD
	Amaranthus spinosus (Kanta-Chaulai)*	H	MD
	Amaranthus virdis (Chaulai)*	H	FD
	Pupalia lappacea (Nagdaminee) *	S	MD
Amaryllidaceae			
	Zephyranthes carinata (Rain Lily)*	H	MS
Anacardiaceae			
	Mangifera indica #	T	MS
	Lannea coromendelica (Jhinghan)*	T	TR,FD
	Rhus cotinus (Tung)*	S	MS
	Rhus parviflora (Tungla)*	S	MD
Apiaceae			
	Centella asiatica (Brahmi)*	H	MD
Apocynaceae			
	Carissa opaca (Karonda)*	S	MS
	Holarrhena antidysenterica (Kura/Kurchi)*	T	TR,FL
	Rauwolfia serpentina (Sarpgandha)*	S	MD
	Vallaris heynei (Dudhi-bel)*	CL	MS
	Wrightia tomentosa (Dudhali)*	T	TR
Asclepiadaceae			
	Calotropis procera (Aak)*	S	MD
	Calotropis gigantea (Mudar)*	S	MD

	Cryptolepis buchananii (Medha-singhi)*	Cl	MD
Arecaceae			
	Phoenix sylvestris (Khajur)*	S	MD
Asteraceae			
	Ageratum conyzoides (Visadodi)*	H	MD
	Artemisia vulgaris #	---	MD
	Artemisia nilagirica (Kunja)*	H	MD
	Artemisia roxburgiana	H	MD
	Bidens biternata (Mangrinya)*	H	MD
	Blumea lacera (Kukronda)*	H	MD
	Cirsium arvense (Kardra)*	H	MD
	Eclipta alba (Bhangaru)*	H	MD
	Eclipta prostrata (Keshraj)*	H	MD
	Emilia sonchifolia (Dudhi)*	H	MD
	Eupatorium odoratum (Tivra gandha)*	S	MD
	Galinsoga ciliata (Blake)*	H	MS
	Gnaphalium leuto-album (Bal-raksha)*	H	MD
	Launnea procumbens (Van-gobhi)*	H	FD
	Parthenium hysterophorus (Gazarghas)*	H	MS
	Sonchus oleraceus (Dudhi)*	H	MD,FD
	Taraxacum afficinale (Dudhiphen)*	H	MD
	Tridax procumbens (Keshraj)*	H	MD
	Xanthium strumarium (Chota-dhatura)*	H	MD
Berberidaceae			
	Berberis lycium (Kingori)*	S	MD
	Berberis asiatica (Kilmora)*	S	MD
	Berberis aristata (Kingora)*	S	MD
Betulaceae			
	Alnus nepalensis (Utis)*	T	TR,FL
	Betula utilis (Bhojpatra)*	T	TR,FL
Bignoniaceae			
	Jacaranda mimosifolia (Nila Gulmohar)*	T	MS
Bombacaceae			
	Bombex ceiba (Semal)*	T	TR,MD
Boraginaceae			
	Cynoglossum zeylanicum (Andhahuli)*	H	MD
	Ehretia leavis (Lasaura)*	T	TR
	Cordia dichotoma (Chamror)*	T	FD,TR
Brassicaceae			

	Capsella bursa-pastoris (Tuntkya)*	H	MD
Buddlejaceae			
	Buddleja asiatica (Bhati)*	S	MD,MS
	Buddleja paniculata (Sendroi)*	S	FL
Cactaceae			
	Opuntia dilleni (Nagphani)*	S	MD
Cannabinaceae			
	Cannabis sativa (Bhang)*	S	MD
Capparaceae			
	Crateva magna (Barna)*	T	MD
Capparidaceae			
	Capparis zeylanica (Hins)*	CL	MD
	Cleome viscosa (Hurhur)*	H	MD
Cornaceae			
	Alangium lamarckii (Bismar)*	T	MD
Caprifoliaceae			
	Viburnum cotonifolium (Bhatyanu)*	S	MD
Caesalpinaceae			
	Bauhinia purpurea (Guiral)*	T	FD,MS
	Bauhinia racemosa (Jhanjhora)*	T	FL
	Bauhinia vahlii (Maljhan)*	CL	FD
	Bauhinia variegata (Kachnar)*	T	FD,MD
	Caesalpinia bonducella (Kath Karanj)*	CL	MD
	Cassia fistula (Amaltas)*	T	ES
	Cassia mimosoides (Patwa ghas)*	H	MD
	Cassia occidentalis (Chakunda)*	H	FL
	Cassia saemea (Kasondi)*	T	MS
	Cassia tora (Panwar)*	H	MD
Chenopodiaceae			
	Chenopodium ambrosioides (Bathua)*	H	MS
	Chenopodium album (Bathua)*	H	MS
Combretaceae			
	Anogeissus latifolia (Bakali)*	T	FD,TR
	Terminalia alata (Sain)*	T	TR
	Terminalia arjuna (Arjun)*	T	TR
	Terminalia bellerica (Bahera)*	T	TR,MD
Commelinaceae			
	Commelina benghalensis (Kanchara)*	H	MD,MS
Convolvulaceae			

	Argyreia nervosa (Ghav bel)*	CL	MD
	Convolvulus arvensis (Heyranpatu)*	H	MD
	Evolvulus alsinoides (Shankhpushpi)*	CL	MD
	Ipomoea carnea (Sadasuhagan)*	S	FL,MD
	Ipomoea nil (Guj)*	CL	FD
	Ipomoea pes-tigris (Panch patri)*	CL	FD
	Merremia tridentate (Prasarini)*	H	MD
Crassulaceae			
	Rhodiolla hytrophylla *	H	MD
	Rosularia adenotricha (Looniya)*	H	MD
	*Sedum adenotrichum**	H	MD
Cupressaceae			
	Juniperus squamata (Thelu)*	S	ES,FL
Cyperaceae			
	Cyperus rotundus (Motha)*	H	MD
Dipterocarpaceae			
	Shorea robusta (Sal)*	----	TR
Ericaceae			
	Rhododendron campanulatum (Don Simris)*	T	MD
Euphorbiaceae			
	Bridelia retusa (Ekdania)*	T	FD,MS
	Emblica officinalis (Aonla)*	T	MD,MS,FD
	Euphorbia hirta (Dudhi)*	H	MD
	*Euphorbia hetrophylla**	H	MD,FD
	Euphorbia rothiana (Thor)*	H	MD
	Jatropha philippinensis (Jatropha)*	S	MS
	Mallotus philippinensis (Rohini)*	T	FD,MD,FL
	Putranjiva roxburghii (Jiaputa)*	T	FD
	Ricinus communis (Arandi)*	S	FL
	Sapium insigne (Khinda)*	T	MD
	Sapium sebiferum (Tarcharvi)*	T	MD
	Trewia nudiflora (Gutel)*	T	MD
Gentianaceae			
	Swertia ciliata (Chirotu)*	H	MD
Geraniaceae			
	Geranium nepalense (Phori)*	H	MD
Grossulariaceae			
	*Curculigo orchioides**	H	MD
	Ribes orientale (Darbag)*	H	MD

	Ribes alpestre (Kali-musli)*	H	MD
Lamiaceae			
	Anisomeles indica (Goplya)*	H	MD
	Calamintha umbrosum (Birchee)*	H	MD
	Colebrookia oppositifolia (Binda/ Pansra)*	S	MD
	Coleus barbatus (Fiwain)*	S	MD
	Hyptis sauveolense (Vilayti tulsi)*	H	MS
	Leucas aspera (Gopha)*	H	MD
	Micromeria biflora (Gorakhopan)*	H	MD
	Ocimum basilicum (Jungli-tulsi)*	H	MD
	Pogostemon plecranthoides (Raudera)*	S	MS
	Roylea cinerea (Baillon Karu)*	H	MD
	Salbia plebeia (Sathi, Samundarsok)*	H	MD
Leeaceae			
	Leea aspera (Kunwai)*	S	MD
Liliaceae			
	Polygonatum cirrhifolium (Khakan)*	H	MD,MS
	Asparagus racemosus (Satrawal)*	S	MD
	Urginea indica *	H	MD
Lythraceae			
	Lagerstroemia parviflora (Dhaudi)*	T	TR
	Punica granatum (Anar)*	T	MS
	Woodfordia fruticosa (Dhaula)*	S	ES
Malvaceae			
	Abutilon indicum (Kanghi)*	S	MD,FL
	Azanza lampas (Jangli bhindi)*	S	MD
	Kydia calycina (Pula)*	T	FD,FL
	Malvastrum coromandelianum (Garcke Suchi)*	H	MD
	Malva parviflora (Soncheli)*	H	MS,MD
	Sida acuta (Bala)*	H	MD,MS
	Sida cordata (Bhiyli)*	H	MD
	Sida cordifolia (Kunghi) #	H	MD
	Sida rhambifolia (Kharenti)*	H	MD,FL
	Thespesia lampas (Ban kapasi)*	S	FL
	Urena lobata (Ungoo)*	H	MD
Martyniaceae			
	Martynia annua (Hathajori)*	H	MD,MS
Meliaceae			
	Azadirachta indica (Neem)*	T	MD,TR,ES

	Toona ciliata (Bakain)*	T	TR
	Melia azedarach (Tun)*	T	TR
Mimosaceae			
	Acacia catechu (Khair)*	T	MD,TR,ES
	Acacia nilotica (Babool)*	T	TR,FL
	Albizia chinensis (Siris) *	T	MS
	Albizia julibrissin (Bhondir)*	T	TR
	Albizia lebbeck (Kala siris)*	T	TR,FL
	*Albizia odoratissima**	T	TR
	*Albizia procera (*Safed siris)*	T	TR
	Mimosa pudica (Lajwanti)*	H	MD
	Mimosa himalayana (Alay)*	S	MD
Moraceae			
	Broussonetia papyrifera (Paper Malburry)*	T	FD,ES
	Ficus bengalensis (Bargad)*	T	TR,ES
	Ficus carica (Anjir)*	T	TR,MS
	Ficus elastica (Rubber)*	T	TR
	Ficus glomerata#	---	FD,MS
	Ficus hispida (Gobla)*	T	FD,MS
	F*icus palmata* (Khemri)*	T	FD,MS
	Ficus racemosa (Gular)*	T	ES
	Ficus religiosa (Pipal)*	T	TR
	*Ficus roxburghii (Timal)**		
	Garuga pinnata (Kharpat)*	T	TR,FD
	Morus alba (Tatri)*	T	MS
Myrsinaceae			
	Ardisia solanacea (Bhatmal)*	S	MD
	Embelia robusta (Gaia)*	S	MD
Myrtaceae			
	Syzygium cumini (Jamun)*	T	TR,MS
Nyctaginaceae			
	Boerhavia diffusa (Punarnava)*	H	MD
	Celosia argentia (Sarwari)*	H	MS
Oleaceae			
	Nyctanthes arbortristis (Harsingar)*	T	ES,FL
Onagraceae			
	Oenothera rosea *	H	MD
Oxalidaceae			
	Oxalis corniculata (Tinpatia)*	H	MD

Papaveraceae			
	Argemone maxicana (Satyanashi)*	H	MD
Pedaliaceae			
	Sesamum indicum (Til)*	H	MD
Pinaceae			
	Abies pindrow (Morinda)*	T	FL,TR
	Cedrus deodara (Deodar)*	T	TR
	Picea smithiana (Roi)*	T	MS,FL
	Pinus roxburghii (Chir)*	T	TR,MS
	Pinus wallichiana (Chir)*	T	TR
Plumbaginaceae			
	Plumbago zeylanica (Chitrak)*	H	MD
Poaceae			
	Apluda mutica (Charol)*	H	FD
	Arundinella nepalensis (Bichhla)*	H	FD
	Arundo donax (Naldura)*	H	ES
	Chloris dolichostachya (Paneri)*	H	FD
	Chrysopogon fulvus (Bhuri)*	H	FD
	Chrysopogon serrulatus (Golden beard grass)*	H	FD
	Cynodon dactylon (Doovghas)*	H	FD,ES
	Dendrocalamus strictus (Bans)*	S	FD,TM
	Deshmostachya bipinnata (Dav, Kush)*	H	MS
	Digiteria sp.*	H	FD
	Eliliopsis binata (Bhabhar ghas)*	H	FD,ES,MS
	Eragrotis cynosuroides #	H	MD
	Heteropogon contortus (Kumeria)*	H	FD
	Imperata cylendrica (Siru pula)*	H	FD,ES,MS
	Oplismenus compositus (Dumdobra kukaria)*	H	FD
	Phragmitis karka (Narkul)*	H	MD
	Polypogon fugax *	H	FD
	Saccharum spontaneum (Muni)*	H	FD,MS
	Vetiveraia zizaniodes (Kans)*	H	ES,FD,MS
	Saccharum munja (Khus)*	H	FD,ES,MS
Polygonaceae			
	Polygonum capitatum (Kaflya)*	H	MS
	Polygonum hydropiper *	H	MD
	Polygonum plebeium (Dondya)*	H	MS
	Rumex hastatus (Chilmora)*	H	MD
	Rumex nepalensis (Khatura)*	H	MS,MD

Portulacaceae			
	Portulaca oleracea (Badinoni)*		MD
Primulaceae			
	Anagallis arvensis (Krishan-neel)*	H	MD
Proteaceae			
	Grevillea robusta (Silver aak)*	T	TR
Papilionaceae			
	Astragalus candolleanus (Rudravanti)*	H	MD
	Butea monosperma (Dhak)*	T	TR,MD
	Dalbergia sissoo (Shisham)*	T	TR
	Desmodium motorium #	------	MD
	Desmodium triflorum (Kandaliya)*	H	MD
	Millettia auriculata (Gauj)*	CL	FD,MS
	Mucuna prurita (Kaircha)*	CL	MD
	Ougeinia oojeinensis (Sandan)*	T	TR,FD
	Psorelea corylifolia #	-------	MD
Ranunculaceae			
	Ranunculas sceleratus (Jaldhania)*	H	MD
	Thalictrum foliolosum (Mamiri)*	H	MD
Rhamnaceae			
	Zizyphus nummalaria (Makoy)*	S	MD,FL
	Zizyphus oenoplia (Ber)*	S	FL,ES,MS
	Zizyphus mauritiana (Jharber)*	S	FL,FD
	Zizyphus xylopyra (Bhander)*	T	FD,MS
Rosaceae			
	Fragaria nubicola (Gand-Kaphal) *	H	MS
	Potentilla cuneata *	H	MD
	Potentilla polyphylla *	H	MD
	Prinsepia utilis (Bhekar)*	S	MS
	Pyracantha crenulata (Panya)*	T	MD
	*Prunus cerasoide*s (Ghangharu)*	S	MD
	Fragaria nubicola (Kujoi)*	S	MS,MD
	Rubus ellipticus (Hisalu)*	S	MD,MS
	Rubus niveus (Bhera)*	S	MS,MD
	Sorbaria tomentosa (Bhiloka)*	S	ES,MS
Rubiaceae			
	Adina cordifolia (Haldu)*	T	TR,ES
	Mitragyna parvifolia (Phaldu, kaim)*	T	TR,ES
	Hymenodictyon excelsum (Phaldu, kaim)*	T	FD,ES

	Wendlandia exserta (Bathua)*	T	MS
Rutaceae			
	Aegle marmelos (Bel)*	T	MD,FD,ES
	Glycosmis mauritiana (Bannimbu)*	S	MD
	Hesperethusa crenulata (Kathbel)*	T	TR,FL
	Murraya koenigii (Karipatta)*	S	MD
	Zanthoxylum armatum (Timru)*	S	MD
Samydaceae			
	Casearia tomentosa (Chilla)*	T	MS
Sapindaceae			
	Dodonaea angustifolia (Wilayti Mehndi)*	S	MD,MS
	Scheichera oleosa (Kusum, Gosum)*	T	TR,FD,ES
Scrophulariaceae			
	Bacopa monnieri (Wilayti Mehndi)*	H	MD
	Verbascum thapsus (Kusum, Gosum)*	H	MD
Simaroubaceae			
	Ailanthus excelsa (Maharukh)*	T	TR
Solanaceae			
	Datura metel (Dhatura)*	S	MD
	Datura suaveolens (Dhatura)*	S	MD
	Physalis minima (Tulatipati)*	H	MS
	Solanum anguivi (Barhanta)*	S	MD
	Solanum indicum (Bhut-Kataia)*	S	MD
	Solanum nigrum (Makoi)*	H	MD
	Solanum surratense (Kantakari)*	S	MD
	*Solanum virginianum**	S	MD
	Withania somnifera (Ashwagandha)*	S	MD
Sterculiaceae			
	Helicteres isora (Kapasi)*	S	MD,MS
	Pterospermum acerifolium (Kanakchampa)*	T	FD
Tamaricaceae			
	Tamarix dioica (Jhau)*	S	MS
Tiliaceae			
	Grewia optiva (Bhimal)*	T	FD,MS
	Triumfetta rhomboidea (Chiki)*	H	MD
Typhaceae			
	Typha elephantina (Patera)*	H	MS
Ulmaceae			
	Celtis australis (Khirak)*	T	TR,FD

	Holoptelia integrifolia (Papari/ Kanju)*	T	TR
Urticaceae			
	Boehmeria platyphyla (Khaksha)*	S	MD
	Boehmeria rugulosa (Genthi)*	T	MS
	Debregeasia longifolia (Tushiari)*	S	MD
	Gerardinia diversifolia (Bichchhu)*	S	MD,MS
	Pouzolzia hirta (Atainyaa)*	H	MD
	Streblus asper (Dahia)*	T	MD,FL
	Urtica dioica (Bichhubooti)*	S	MD,MS
Verbenaceae			
	Callicarpa macrophylla (Daia)*	S	MD
	Clerodendrom viscosum (Bhant)*	S	MD
	Clerodendrom serratum (Banbahri)*	S	MD
	Lantana camera (Kurrii)*	S	FL
	Tectona grandis (Sagaun)	T	TR
	Vitex negundo (Nirgundi)	S	MD

- **Abbreviations**: T-Tree; S-Shrub; H-Herb; Cl-Climber; MD-Medicinal; FD-Fodder; TR-Timber; FL-Fuel; ES-Ecological/ Environmental specific and MS-Miscellaneous value.
- Common name is given in brackets.
- Station/ Location

  * Gangotri to Haridwar

  # Saptrishi

Annexure-III

Dominant and rare flora along the Bhagirathi-Ganga at various sites between Haridwar to Gangotri during 2005-2007 (Gangwar and Gangwar, 2011)

Dominant/Rare species at different sites	
Haridwar	
Left Bank	**Right Bank**
Dominant Species *Accacia catechu, Dalbergia sissoo, Mallotus philliensis, Syzygium cumini, Trewia nudiflora, Lantana camera, Murraya koenigii, Sida cordata, Sida cordifolia*	***Dominant Species*** *Holoptelia integrifolia, Bombex ceiba, Trewia nudiflora, Lantana camera, Sida cordifolia, Sida acuta, Dasmodium trifloreum*
Rare Species *Ficus carica, Putrangiva roxberghii, Streblus asper, Terminalia arjuna, Citrus medica, Ocimum basillicum, Rauwolfia serpentine, Ricinus cummunis, Solanum indicum, Apluda mutica, Argemone maxicana, Centella asiatica, Cleome viscose, Emilia sonchifolia, Hyptis sauveolense, Ipomoea nil, Leucas aspera, Phyla nudiflora, Portulaca oleracea, Ranunculus sceleratus, Saccharum spontaneum, Xanthium strumarium*	***Rare Species*** *Aegle mermelos, Azadirachta indica, Casearia tomentosa, Lannea coromandelica, Sapium sebiferum, Terminalia bellarica, Citrus medica, Dendrocalamus strictus, Uraria rufescens, Vitex negundo, Cassia mimosoides, Martynia annua, Merremia tridentala, Phyla nudiflora. Polygonum hydropiper, Porulaca oleracea, Ranunculus sceleratus, Rungia pectinata, Urginea indica*
Shaympur	
Left Bank	**Right Bank**
Dominant Species *Accacia catechu, Cassia fistula, Holarrehena antidysenterica, Bombex ceiba, Mallotus phillipinensis, Sida acuta*	***Dominant Species*** *Accacia catechu, Aegle, marmelos, Bombex ceiba, Dalbergia sissoo, Sapium sebiferum, Lantana camera,, Colebrookia oppositifollia,, Parthenium hysterophorus*
Rare Species *Emblica officinalis, Ficus religosa, Pterospermum acerifolium, Cannabis sativa, Nyctanthes arbortristis, Solanum indicum, Argemone maxicana, Boerhavia diffusa, Cassia tora, Eclipta prostrate, Euphorbia hitra, Imperata cylindrica,*	***Rare Species*** *Azairachta indica, Casearia tomentosa, Crateva magna, Crateva magna, Ehretia leasis, Emblica officinalis, Ficus benghalensis, Schleichera oleosa, Sygyzium cumini, Tectona grandis, Termina bellerica, Wrightia*

Triumfetta rhomboidea, Urena lobata	*tomentosa, Abutilon indicum, Ardisia solanaceas, Callicarpa macerophylla, Ipomoea carnea, Jatropha curcas, Nyctanthes arbortristis, Opuntia dilleni, Tamarix dioica, Abrus precatoriuns, Apluda mutica, Ipomoea nil, Martynia annua, Physalis minima, Polygonum hydropiper, Saccharum munja, Solanum nigrum, Solanum surratense, Typha elephantine, Urena lobata*
Rishikesh	
Left Bank	**Right Bank**
Dominant Species *Mallotus phillipinensis, Holoptelia integrifolia, Adina cardifolia* ***Rare species*** *Acacia catechu, Ailanthus excels, Albizia procera, Azadirachta indica, Cassia saemea, Dalbergia sissoo, Ficus benghalensis, Ficus racemosa, Ficus religosa, Garuga pinnata, Holarrehena antidysenterica, Kydia calycina, Lannea coromandelica, Melia azadirachta, Terminalia bellerica, Calotropis procera, Carissa opaca Anagallis arvensis, Cynoglossum zeylanicum*	***Dominant Species*** *Holoptelia integrifolia, Adina cardifolia, Parthenium hysterophorus* ***Rare species*** *Acacia catechu, Albizia procera, Ficus elastic, Ficus religosa, Hesperethusa crenulata, Melia azadirachta, Terminalia arjuna, Bauhinia vahlii, Boehmeria platyphyla, Calotropis procera, Ipomoea carnea, Opuntia dilleni, Solanum indicum, Apluda mutica, Barleria priontis, Boerhavia diffusa, Chloris dolichostachya, Deshmostachya bipinnata, Phragmitis karka, Saccharum munja, Saccharum spontaneum, Urena lobata*
Shivpuri	
Left Bank	**Right Bank**
Dominant Species *Dalbergia sissoo, Shorea robusta, Holoptelia integrifolia, Colebrookia oppositifolia, Adhatoda zeylanica, Cassia occidentalis*	***Dominant Species*** *Mallotus phillipinensis, Holoptelia integrifolia, Adina cardifolia, Adhatoda zeylanica, Lantana camera, Ageratum conyzoides, Parthenium hysterophorus*

Rare Species	***Rare Species***
Melia azedirach, Calotropis gigautia, Cryptolepis buchananii, Jatropa curcas, Abrus precatorius, Anisomeles indica, Solanum surratense, Triumfetta rhomboidea	*Bridelia retusa, Wrightia tomentosa, Millettia auriculata, Plumbago zeylanica, Solanum anguivi, Thespesia lanpas, Centella asiatica, Cynoglossum zeylanicum, Desmostachya bipinnata, Mucuna prurita, Ocimum bacillicum, Sida cordata, Xanthium strumasium*
Devpryag	
Left Bank	**Right Bank**
Dominant Species	***Dominant Species***
Adhatoda zeylanica, Murraya koenigii, Lantana camera, Tridax procumbens	*Tamarindus indica, Mallotus phillipinensis, Lantana camera, Adhatoda zeylanica, Murraya koenigii, Eupatorium odoratum*
Rare Species	***Rare Species***
Adina cardifolia, Dalbergia sissoo, Ficus racemosa, Ficus benghalensis, Hymenodictyon excelsum, Mitragyna parvifolia, Agave americana, Euphorbia royleana, Ricinum communis, Withania somifera, Apluda mudica, Celosia argentia, Chrysopogon serrulatus, Eclipta alba, martynia annua, Physalis minima, Scutellaria scandens, Xanthium strumarium	*Bridelia retusa, Emblica officinalis, Lagerstroemia parviflora, Lannea coromandelica, Ougeinia oojeionensis, Azanza lampas, Emblica robusta, Withani somifera, Euphorbia hirta, Leucas aspera, Oplismenus composites, Physalis minima, Solanum nigrum, Vernonia cinera*
Tehri	
Left Bank	**Right Bank**
Dominant Species	***Dominant Species***
Dalbergia sissoo, Bombex ceiba	*Varbascum thapsus*
Rare Species	***Rare Species***
Aegle marmelos, Albizia odoratissima, Broussonetia papyrifera, Ficus religosa, Syzygium cumini, Toona ciliate, Calotropis gigantean, Withania somifera, Achyranthes aspera, Amaranthus caudatus, Boerhavia	*Accacia catechu, Albizia odoratissima, Ficus roxburghii, Punaca granatum, Schleichera oleosa, Buddlega astatica, Carisa opaca, Debregeasia longifolia, Datura metel, Zyzyphus mauritiana, Achyranthus aspera, Ageratum*

diffusa, Cassia occidentalis, Eclipta prostrate, Euphorbia procumbens, Polygonum hydropiper, Sida cordata, Tridax procumbens, Xanthium strumarium	*connyzoides, Centella asiatica, Cynodon dictilon, Cyprus rotundus, Eclipta prostrate, Indigofera cordofolia, Mimosa pudica, Oxalix corniculata, Polygonum hydropiper, Urena lobata*
Uttarkashi	
Left Bank	**Right Bank**
Dominant Species *Pinus roxburgii , Urtica dioica, Rumex haxtatus* ***Rare Species*** *Albizia odoratissima, Ficus religosa, Toona ciliate, Indigofera girardiana, Achyranthus aspera, Datura metel, Zyzyphus mauritiana, Morus alba, Agave americana, Euphorbia rothiana, Jatropha curcas, Prinsepia utilis, Woodfordia friticosa, Altenanthera sissilis, Anagalis arvensis, Argemone maxicana, Bidens biternata, Blumea lacera, Cassia tora, Coleus bartus, Digiteria sp. Fragaria nubicola, Galinosa ciliate, Imperata cylindrica, Micromeria biflora Rosularia* sp.*, Sedum adenotricum, Sonchus oleraceus, Typha elephantine*	***Dominant Species*** *Urtica dioica* ***Rare Species*** *Ficus religosa, Morus alba, Galinosa ciliate, Jatropha curcas, Agave americana, Euphorbia rothiana, Ficus carica, Grewia oppositifolia, Boehmeria platyphyla, Pyracantha crenulata, Alternanthera sissilis, Amaranthus spinosus, Argemone maxicana, Blumea lacera, Cynodon dactylon, Lannea nudicaulis, Polypogon fugax, Solanum indicum, Xanthium strumarium*
Maneri-Bhali	
Left Bank	**Right Bank**
Dominant Species *Alnus nepalensis, Eupatorium odoratum, Rubus ellipticus, Urtica dioica* ***Rare Species*** *Albizia julibrissin, Bauhinia purpurea, Bombex ceiva, Ficus auriculata, Grivillea robusta, Bidens biternata, Cannabis sativa, Lantana camera, Rosa moschata, Solanum indicum, Artimissia nilagrica, Calamintha umbrosa, Geranium*	***Dominant Species*** *Eupatorium odoratum, Rumax hastatus, Rubus niveus* ***Rare Species*** *Alnus nepalensis, Ficus auriculata, Bidens biternata, Debregeasia longifolia, Prunus cerasoides, Zanthoxylum armatum, Calamintha umbrosa, Fragaria nubicola, Oenothera rosea, Zephyanthes carinata*

nepalense, Oenothera rosea, Polygonium capitatum, Polypogon fugax	
Lanka	
Left Bank	**Right Bank**
Dominant Species	***Dominant Species***
Cedrus deodara	*Cedrus deodara*
Rare Species	***Rare Species***
Berberus aristata, Sorbaria tomentosa	*Berberus aristata, Cannabis sativa, Cotoneaster acuminalis, Sorbaria tomentosa*
Gangotri	
Left Bank	**Right Bank**
Dominant Species	***Dominant Species***
Cedrus deodara	*Cedrus deodara*
Rare Species	***Rare Species***
Betula Utilis, Picea smithiana, Juniperus squamata, Brassica juancea, Salvia plebeian, Taraxacum afficinala	*Acer cappadocicum, Berberis aristata, Salix flabellasis, Sorbesia tomentosa, Polygonatum cirrhifolium, Salvia plebeian, Taraxacum afficinale*