



Original Research Article

A Survey of Riparian Vegetation of River Manuni in Western Himalayan Region of India

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Abstract	Keywords
<p>Himachal Pradesh is drained by five main rivers and their tributaries. These are Chenab, Ravi, Beas, Sutlej and Yamuna. River Manuni originates from the southern slopes of the Dhauladhar range and joins Baner at Sangam on the rear side of the Kangra fort to finally meet River Beas near Haripur in District Kangra of Himachal Pradesh. The banks of this river offer very good habitats for the growth of riparian vegetation. The riparian vegetation is not only important for regulating nutrient cycle of the streams, preventing soil erosion and stabilizing river banks but also play a very important role in regulating the aquatic-terrestrial linkages. The present study is an attempt to survey the riparian vegetation of River Manuni between Khaniyara and Purana Kangra and was undertaken between the period March 2009 and February 2011.</p>	<p>Climbers Herbs Riparian vegetation River Manuni Shrubs Trees</p>

Introduction

The Himalaya forms an integral part of the High Asia and is *par excellence* the mountain of India (Mani, 1968). Geographically, the Himalaya is divided into- Eastern Himalaya, Central Himalaya, Western Himalaya and Northwest Himalaya. Himachal Pradesh lies in Northwest Himalaya and is drained by five major rivers and their tributaries. These are Chenab, Ravi, Beas, Sutlej and Yamuna. Manuni is a part of River Beas drainage system.

Manuni originates from the southern slopes of Dhauladhar range (Upper reaches of Dhauladhar above

Khaniyara village) in District Kangra of Himachal Pradesh and is locally called as 'Manuni Khad'. It is a perennial snow fed stream emanating from the Dhauladhar range and flowing from North towards South in the Beas basin. A number of streamlets both perennial and non-perennial emerge from Dhauladhar range to form the main River Manuni. The river originates from the high mountainous elevation of 4800m asl. The area forms a part of lesser Himalayan zone. The initial reaches of this 'Khad' are snow-fed. Steep slopes form the upper catchment of the River Manuni. It is covered by small glaciers in the upper

and dense forest in the lower ridges. The catchment area receives very heavy rainfall during monsoon months. The river joins Baner (a tributary of Beas) on the rear side of Kangra fort at Sangam to finally meet the River Beas near Haripur in District Kangra of Himachal Pradesh. River Beas thereafter flows into the Pong Dam.

The study of riparian vegetation of a river is an important as it strongly affects soil-water characteristics of the area and thus the aquatic life. Moreover, the vegetation provides the human population with vital life support and socio-economic security (Pandit et al., 2000). Recent research on river processes has focused on the immediate riparian zone (shoreline communities) or land use pattern and type adjacent to river (Corkum, 1999).

Riparian zones often regulate aquatic-terrestrial linkages. Riparian vegetation is important for regulating nutrient cycle of the streams, preventing soil erosion and stabilizing river banks. Further, the riparian vegetation is modified or destroyed by grazing, logging, urbanization, road construction, water development, mining and recreation (Knight and Bottorff, 1981). Also, the riparian zone is thought to have a disproportionate influence (relative to its land area) on the running water because of its immediate effects on the transport of water, nutrients and sediments (Peterjohan and Correll, 1984). Yet there are conflicting reports on whether small scale (riparian) vegetation or large scale (basin-wide) factors are more important in influencing the biological integrity in streams. The apparent significance of riparian vegetation or land use on receiving water will depend on the scale or scope of study (Frissel et al., 1986). Allan et al. (1997) showed that regional vegetation away from the river channel affected channel forms as well as nutrients.

Owing to diversified climatic conditions, Kangra Valley of Himachal Pradesh supports a wide range of riparian flora. Since the plant life found around the stream or river banks keep the aquatic ecosystem alive and thriving, it needs to be regulated carefully and monitored regularly for the functional viability of the ecosystem. The present study is an attempt in this direction to survey the vegetation of Manuni watershed in district Kangra of Himachal Pradesh.

Materials and methods

Study area and climate

Himachal Pradesh located between 30°22'-33°12' North latitude and 75°45'-79°04' East longitude, is a mountainous state of north India with altitude varying from 350 to 7000 msl. To its East it forms India's border with Tibet, to the North lies state of Jammu and Kashmir, Uttarakhand in the Southeast, Haryana in South and Punjab in West. Himachal Pradesh is divided into four physiographic ranges namely- Outer Himalaya / Siwaliks (350-1500 m asl), Lesser Himalaya (1500-5000 m asl), Great Himalaya (5000-6000 m asl), and Spiti / Tethys Himalaya (More than 6000 m asl) (Central Groundwater H.P. State Profile, 2010).

There is a general increase in elevation from West to East and from South to North. Based on the above physiographic zonation, Manuni watershed falls in outer and lesser Himalayan range, though the study area falls in outer Himalayan range only. Manuni is a tributary of River Beas and originates from the southern slopes of Dhauladhar range in district Kangra and joins river Baner (another tributary of Beas) on the rear site of the historical Kangra fort to finally meet river Beas near Haripur. The study area falls in Survey of India Topographic sheet 52 D/8 and is located between latitude 32°5'-32°15' North and longitude 76°15'-76°25' East. At lower elevation in the Manuni watershed, the climate is sub-tropical, whereas at higher heights it is temperate. Semi-arctic conditions prevail along the main Dhauladhar range during winter season. Conventionally the year is divided into three seasons namely, Hyund or Cold season or Sardiyan or Winter (October to February), Taundi or Hot season or Garmiyan (March to June) and Barsat or Rainy season or Monsoon (July to September). The area experiences very heavy rainfall during monsoon. The exceptional heavy rainfall is due to interplay of monsoon currents and sudden rise in the heights of Dhauladhar and particular alignment of mountain ranges and hills (Kayastha and Mishra, 2003).

Methodology

Seasonal floristic survey of Manuni watershed within an altitude of 610-1240 m (asl) was conducted during March 2009 to February 2011. The plants were identified and enumerated alphabetically mainly on the

basis of Collett (1921), Chowdhery and Wadhwa (1984), Singh (1996), Polunin and Stainton (1997), Gaur (1999) and Kumar (2000). Thereafter these were classified into four categories i.e., trees, shrubs, herbs and climbers (Table 1).

Results and discussion

During the present survey 58 genera of trees, 34 genera of shrubs, 64 genera of herbs and 12 genera of climbers have been identified in the Manuni watershed (Table 1). Upstream to Khaniyara there is a sudden rise in the elevation of Dhauladhar mountain, which reaches over 3700m. Due to difficult terrain and inaccessibility this part of the Manuni watershed was not included in the present study. However, some of the evident important vegetational elements of the higher reaches of Dhauladhar are *Acer caesium* (Mandar), *Aconitum heterophyllum* (Patis),

Cotoneaster microphylla (Res), *Diplazium frondosum* (Lugru), *Fagopyrum tataricum* (Fafu), *Gentiana kurroo* (Karu), *Jurinea dolomiaea* (Dhoop), *Pieris ovalifolia* (Ailan), *Quercus leucotrichophora* (Ban) and *Rhododendron arboreum* (Barah).

Conspicuously, *Cedrus deodara* (Deodar) is generally absent in the watershed which may be due to the heavy rainfall in the area and slate formation of rocks (Singh, 1996). A few trees of *Cedrus deodara* planted by local people can be seen up to as low as 1250 m in Khaniyara. Much of the natural vegetation at lower altitude i.e. downstream to Khaniyara has been replaced by irrigated terraces locally known as 'Khet'. The major crops cultivated in the area are wheat and rice in rotation along with maize and pulses etc. However, in recent years people have started taking interest in growing cash crops like sugar cane, potatoes and vegetables etc. in lower part of Manuni watershed.

Table 1. Riparian vegetation (trees and shrubs) of river Manuni, Himachal Pradesh.

Sr. No.	Tree	Family	Shrubs	Family
1.	<i>Acacia catechu</i> (L.f.)Willd.	Mimosaceae	<i>Adhatoda vasica</i> Nees	Acanthaceae
2.	<i>Aegle marmelos</i> (L.) Corr.	Rutaceae	<i>Agave americana</i> L.	Agavaceae
3.	<i>Albizia stipulata</i> (DC.) Boivin	Mimosaceae	<i>Berberis aristata</i> DC.	Berberidaceae
4.	<i>Albizia odoratissima</i> (L.f.) Benth.	Mimosaceae	<i>Boehmeria macrophylla</i> D.Don	Urticaceae
5.	<i>Bauhinia variegata</i> L.	Caesalpiniaceae	<i>Bambusa arundinacea</i> (Retz.) Willd.	Poaceae
6.	<i>Bombax ceiba</i> L.	Bombacaceae	<i>Brugmansia suaveolens</i> Berch.& J.S.Presl	Solanaceae
7.	<i>Cassia fistula</i> L.	Caesalpiniaceae	<i>Camellia sinensis</i> (L.) Kuntze	Theaceae
8.	<i>Toona hexandra</i> (Wall. ex Roxb.)Roem.	Meliaceae	<i>Carissa spinarum</i> L.	Apocynaceae
9.	<i>Celtis australis</i> L.	Ulmaceae	<i>Colebrookia oppositifolia</i> J.E.Smith	Lamiaceae
10.	<i>Cinnamomum tamala</i> (Buch-Ham) Nees & Ebe Urn.	Lauraceae	<i>Cotoneaster acuminatus</i> Lindley	Rosaceae
11.	<i>Citrus aurantium</i> L.	Rutaceae	<i>Debregeasia longifolia</i> (B.f.) Wedd.	Urticaceae
12.	<i>Citrus medica</i> L.	Rutaceae	<i>Dodonaea viscosa</i> (L.) Jacq.	Sapindaceae
13.	<i>Cordia dichotoma</i> Forster f.	Ehretiaceae	<i>Duranta repens</i> L.	Verbenaceae
14.	<i>Dalbergia sissoo</i> Roxb.	Fabaceae	<i>Euphorbia royleana</i> Boissier	Euphorbiaceae
15.	<i>Dendrocalamus strictus</i> (Roxb.) Nees	Poaceae	<i>Flacourtia ramontchi</i> L.Herit.	Flacourtiaceae
16.	<i>Diosypros montana</i> Roxb.	Ebenaceae	<i>Jatropha curcas</i> L.	Euphorbiaceae
17.	<i>Ehretia acuminata</i> R.Br.	Ehretiaceae	<i>Lantana camara</i> L.	Verbenaceae
18.	<i>Cassine glauca</i> (Rottb.) Kuntz.	Celastraceae	<i>Murraya koenigii</i> (L.) Sprengel	Rutaceae
19.	<i>Embliba officinalis</i> Gaertner	Euphorbiaceae	<i>Myrsine africana</i> L.	Myrsinaceae
20.	<i>Eucalyptus citriodora</i> Hook.	Myrtaceae	<i>Opuntia vulgaris</i> Miller	Cactaceae
21.	<i>Ficus benghalensis</i> L.	Moraceae	<i>Piper nepalense</i> Miq.	Piperaceae
22.	<i>Ficus glomerata</i> Roxb.	Moraceae	<i>Plumbago zeylanica</i> L.	Plumbaginaceae
23.	<i>Ficus hispida</i> L.f.	Moraceae	<i>Pogostemon plectranthoides</i> Desf.	Lamiaceae
24.	<i>Ficus palmata</i> Forsk.	Moraceae	<i>Prinsepia utilis</i> Royle	Rosaceae
25.	<i>Ficus racemosa</i> L.	Moraceae	<i>Ricinus communis</i> L.	Euphorbiaceae

Sr. No.	Tree	Family	Shrubs	Family
26.	<i>Ficus religiosa</i> L.	Moraceae	<i>Rosa macrophylla</i> Lindley	Rosaceae
27.	<i>Ficus roxburghii</i> Wall.ex Miq.	Moraceae	<i>Rubus ellipticus</i> Smith	Rosaceae
28.	<i>Ficus rumphii</i> Blume	Moraceae	<i>Rubus niveus</i> Thunb.	Rosaceae
29.	<i>Grevillea robusta</i> A.Cunn. ex R.Br.	Proteaceae	<i>Sarcococca saligna</i> (D.Don) Muell.-Arg.	Buxaceae
30.	<i>Grewia optiva</i> Drumm. ex Burret	Tiliaceae	<i>Urtica dioica</i> L.	Urticaceae
31.	<i>Hymenodictyon excelsum</i> (Roxb.)Wallich	Rubiaceae	<i>Vitex negundo</i> L.	Verbenaceae
32.	<i>Jacaranda mimosifolia</i> D. Don	Bignoniaceae	<i>Woodfordia fruticosa</i> (L.) Kurz	Lythraceae
33.	<i>Juglans regia</i> L.	Juglandaceae	<i>Zanthoxylum armatum</i> D.C.	Rutaceae
34.	<i>Lannea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae
35.	<i>Litchi chinensis</i> Sonn.	Sapindaceae	-	-
36.	<i>Neotitsea pallens</i> (D. Don)Momy.	Lauraceae	-	-
37.	<i>Mallotus philippensis</i> (Lam.)Muell.-Arg.	Euphorbiaceae	-	-
38.	<i>Mangifera indica</i> L.	Anacardiaceae	-	-
39.	<i>Melia azedarach</i> L.	Meliaceae	-	-
40.	<i>Ougeinia oojeinensis</i> (Roxb.)Hochr.	Fabaceae	-	-
41.	<i>Oroxylum indicum</i> (L.)Vent.	Bignoniaceae	-	-
42.	<i>Phoenix sylvestris</i> (L.)Roxb.	Arecaceae	-	-
43.	<i>Pinus roxburghii</i> Sargent	Pinaceae	-	-
44.	<i>Pistacia integerrima</i> Stewart	Anacardiaceae	-	-
45.	<i>Prunus amygdalus</i> Batsch.	Rosaceae	-	-
46.	<i>Prunus cornuta</i> (Wall.ex.Royle) Stend.	Rosaceae	-	-
47.	<i>Prunus persica</i> (L.) Batsch.	Rosaceae	-	-
48.	<i>Psidium guajava</i> L.	Myrtaceae	-	-
49.	<i>Punica granatum</i> L.	Punicaceae	-	-
50.	<i>Pyrus pashia</i> Buch.-Ham.ex D.Don	Rosaceae	-	-
51.	<i>Catunaregum spinosa</i> (Thunb.)Tirveng.	Rubiaceae	-	-
52.	<i>Salix tetrasperma</i> Roxb.	Salicaceae	-	-
53.	<i>Sapindus mukorossi</i> Gaertner	Sapindaceae	-	-
54.	<i>Sapium sebiferum</i> (Mich.)Roxb.	Euphorbiaceae	-	-
55.	<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	-	-
56.	<i>Terminalia arjuna</i> (Roxb.ex D.C.) Wight & Arn.	Combretaceae	-	-
57.	<i>Terminalia bellirica</i> (Gaertner) Roxb.	Combretaceae	-	-
58.	<i>Terminalia chebula</i> Retz.	Combretaceae	-	-

Table 2. Riparian vegetation (herbs and climbers) of river Manuni, Himachal Pradesh.

Sr. No.	Herbs	Family	Climbers	Family
1.	<i>Abelmoschus crinitus</i> Wall.	Malvaceae	<i>Bauhinia vahlii</i> Wight and Arn.	Caesalpiaceae
2.	<i>Achyranthes aspera</i> L.	Amaranthaceae	<i>Bougainvillea glabra</i> Choisy	Nyctaginaceae
3.	<i>Acorus calamus</i> L.	Araceae	<i>Celastrus paniculatus</i> Willd.	Celastraceae
4.	<i>Ageratum conyzoides</i> L.	Asteraceae	<i>Cissampelos pareira</i> L.	Menispermaceae
5.	<i>Apluda aristata</i> L.	Poaceae	<i>Cuscuta reflexa</i> Roxb.	Cuscutaceae
6.	<i>Arabis amplexicaulis</i> Edgew.	Brassicaceae	<i>Dioscorea bulbifera</i> L.	Dioscoreaceae
7.	<i>Arisaema wallichianum</i> Hook.f.	Araceae	<i>Hydrangea anomala</i> D.Don	Hydrangeaceae
8.	<i>Artemisia nilagirica</i> (C.B.Clar.) Pamp.	Asteraceae	<i>Ichinocarpus frutescens</i> (L.) R. Br.	Apocynaceae
9.	<i>Arthraxon lanceolatus</i> (Roxb.)Hochst.	Poaceae	<i>Ipomoea alba</i> L.	Convolvulaceae

Sr. No.	Herbs	Family	Climbers	Family
10.	<i>Barbarea vulgaris</i> R.Br.	Brassicaceae	<i>Mucuna pruriens</i> (L.)DC.	Fabaceae
11.	<i>Barleria cristata</i> L.	Acanthaceae	<i>Rosa brunonii</i> Lindley	Rosaceae
12.	<i>Basella rubra</i> L.	Basellaceae	<i>Tinospora cordifolia</i> (Willd.)Hook.f.&Thoms.	Menispermaceae
13.	<i>Bidens bipinnata</i> L.	Asteraceae	-	-
14.	<i>Bistorta macrophylla</i> (D.Don)Sojak	Polygonaceae	-	-
15.	<i>Blepharis maderaspatensis</i> (L.) Roth	Acanthaceae	-	-
16.	<i>Cannabis sativa</i> L.	Cannabiaceae	-	-
17.	<i>Cardamine flexuosa</i> Wither.	Brassicaceae	-	-
18.	<i>Cassia tora</i> L.	Caesalpiniaceae	-	-
19.	<i>Chrysopogon aciculatus</i> (Retz.)Trin.	Poaceae	-	-
20.	<i>Circium wallichii</i> DC.	Asteraceae	-	-
21.	<i>Colocasia esculenta</i> (L.)Schott	Araceae	-	-
22.	<i>Cynodon dactylon</i> (L.)Pers.	Poaceae	-	-
23.	<i>Cynoglossum lanceolatum</i> Forsk.	Boraginaceae	-	-
24.	<i>Cyanotis cristata</i> (L.)D.Don	Commelinaceae	-	-
25.	<i>Didymocarpus pedicellatus</i> R.Br.	Gesneriaceae	-	-
26.	<i>Duchesnea indica</i> (Andrewes) Focke	Rosaceae	-	-
27.	<i>Echinops echinatus</i> Roxb.	Asteraceae	-	-
28.	<i>Eriophorum comosum</i> (Wall.)Wall. ex Nees	Cyperaceae	-	-
29.	<i>Eulaliopsis binata</i> (Retz.)Hubbard	Poaceae	-	-
30.	<i>Eupatorium adenophorum</i> Spreng.	Asteraceae	-	-
31.	<i>Galium aparine</i> L.	Rubiaceae	-	-
32.	<i>Gentiana kurroo</i> Royle	Gentianaceae	-	-
33.	<i>Mentha longifolia</i> (L.)Hudson	Lamiaceae	-	-
34.	<i>Micromeria biflora</i> (Buch.- Hem.ex D.Don)Benth.	Lamiaceae	-	-
35.	<i>Musa paradisiaca</i> L.	Musaceae	-	-
36.	<i>Nasturtium officinale</i> R.Br.	Brassicaceae	-	-
37.	<i>Nepeta hindostana</i> (Roth)Haines	Lamiaceae	-	-
38.	<i>Oxalis corniculata</i> L.	Oxalidaceae	-	-
39.	<i>Parthenium hysterophorus</i> L.	Asteraceae	-	-
40.	<i>Persicaria barbata</i> (L.)Hara	Polygonaceae	-	-
41.	<i>Peristrophe paniculata</i> (Forsk.) Brum.	Acanthaceae	-	-
42.	<i>Pilea umbrosa</i> Wedd.	Urticaceae	-	-
43.	<i>Poa annua</i> L.	Poaceae	-	-
44.	<i>Polygonum recumbens</i> Royle ex Bab.	Polygonaceae	-	-
45.	<i>Potentilla fulgens</i> Wall.ex Hook.	Rosaceae	-	-
46.	<i>Pouzolzia zeylanica</i> (L.) J.Bennett and Brown	Urticaceae	-	-
47.	<i>Ranunculus arvensis</i> L.	Ranunculaceae	-	-
48.	<i>Reinwardtia indica</i> Dumort..	Linaceae	-	-
49.	<i>Rumex hastatus</i> D.Don	Polygonaceae	-	-
50.	<i>Saccharum bengalensis</i> Retz.	Poaceae	-	-
51.	<i>Saxifraga diversifolia</i> Wall.ex Seringe	Saxifragaceae	-	-
52.	<i>Senecio nudicaulis</i> Buch.-Ham.ex D.Don	Asteraceae	-	-
53.	<i>Sida acuta</i> Burm. f.	Malvaceae	-	-
54.	<i>Solanum nigrum</i> L.	Solanaceae	-	-

Sr. No.	Herbs	Family	Climbers	Family
55.	<i>Solanum viarum</i> Dunal	Solanaceae	-	-
56.	<i>Sonchus asper</i> (L.) Hill	Asteraceae	-	-
57.	<i>Stellaria media</i> (L.) Vill.	Caryophyllaceae	-	-
58.	<i>Strobilanthes auriculata</i> Nees	Acanthaceae	-	-
59.	<i>Taraxacum officinale</i> Weber	Asteraceae	-	-
60.	<i>Thalictrum foliolosum</i> DC.	Ranunculaceae	-	-
61.	<i>Thysanolaena maxima</i> (Roxb.) Kuntze	Poaceae	-	-
62.	<i>Trigonella incisa</i> Benth.	Fabaceae	-	-
63.	<i>Vanda testacea</i> (Lindl.) Reichb.	Orchidaceae	-	-
64.	<i>Verbena officinalis</i> L.	Verbenaceae	-	-

The common trees found in the study area are *Bauhinia variegata*, *Dendrocalamus strictus*, *Eucalyptus citriodora*, *Ficus religiosa*, *Grewia optiva*, *Mallotus philippensis*, *Mangifera indica*, *Pyrus pashia* etc. Similarly the common shrubs found in the Manuni watershed are *Adhatoda vasica*, *Agave americana*, *Duranta repens*, *Lantana camara*, *Murraya koenigii* and *Urtica dioica* etc. Whereas the common herbs found are *Ageratum conyzoides*, *Barleria cristata*, *Eupatorium adenophorum*, *Galium aparine*, *Nasturtium officinale* and *Taraxacum officinale* etc. Similarly *Mucuna pruriens* and *Tinospora cordifolia* are the common climbers in the watershed. Taxa of rare occurrence were *Acorus calamus*, *Cotoneaster acuminatus*, *Cyanotis cristata*, *Diosypros montana*, *Syzygium cumini*, *Gentiana kurroo*, *Jatropha curcus*, *Pistacia integerrima*, *Randia dumetorum*, *Senecio nudicaulis*, *Terminalia arjuna* and *Woodfordia fruticosa*.

Besides timber and fuel, there are large numbers of plants in the Manuni watershed which are a source of valuable non-timber forest products. Based on the classification of non-wood forest produce in India by Gupta and Guleria (1982) some important fruits, nuts and edible products yielding plants in Manuni watershed are *Aegle marmelos*, *Citrus aurantium*, *Citrus medica*, *Embllica officinalis*, *Juglans regia*, *Mangifera indica*, *Prunus spp.*, *Rubus spp.*, *Ziziphus sp.* etc.; resin is obtained from plants like *Pinus roxburghii*; tannin and dyes from *Acacia catechu*, *Carissa spinarum*, *Toona hexandra*, *Lannea coromandelica*, *Pistacia integerrima*, *Terminalia chebula*, and *Ziziphus*. The medicinal plants recorded in the watershed are *Acorus calamus*, *Aegle marmelos*, *Berberis aristata*, *Cassia fistula*, *Cinnamomum tamala*, *Ficus glomerata*, *Mallotus philippensis*, *Pinus roxburghii*, *Rhododendron arboreum*, *Syzygium cumini*, *Terminalia arjuna*, *Terminalia chebula*, and

Tinospora cordifolia etc. Fibre and floss yielding ones are like *Agave americana*, *Bombax ceiba*, *Grewia optiva* etc. and the essential oils are obtained from *Cedrus deodara*, *Eucalyptus sp.*, *Cinnamomum tamala* and *Pinus roxburghii*.

Also, the some of the economically overexploited plant species found in the watershed among trees are *Acacia catechu*, *Toona hexandra*, *Cinnamomum tamala*, *Ougeinia oojeinensis* and *Sapindus mukorossi* etc., among shrubs are *Berberis aristata*, *Plumbago zeylanica*, *Vitex negundo* and *Zanthoxylum armatum* etc. and among herbs are *Barleria cristata* and *Didymocarpus pedicellatus* etc. Interestingly, during the present survey it was observed that some plants occupied vast area as compared to others, such rapidly multiplying 'selfish' plants are gradually degrading the habitat for normal perpetuation of native species. Some of the important newly introduced invasive plants in Manuni watershed are *Ageratum conyzoides*, *Eupatorium adenophorum*, *Lantana camara* and *Parthenium hysterophorus*. Similarly the ecologically sensitive species like *Acorus calamus* and *Gentiana kurroo* etc. have also been found in the Manuni watershed.

Some species useful in soil conservation of the study area include *Toona hexandra*, *Dalbergia sissoo*, *Ficus religiosa*, *Ficus hispida*, *Ficus benghalensis*, *Mallotus philippensis* among the trees, *Adhatoda vasica*, *Agave americana*, *Berberis aristata*, *Colebrookia oppositifolia*, *Flacourtia ramontchi* and *Ziziphus mauritiana* among shrubs and *Cyanotis cristata*, *Didymocarpus pedicellatus*, *Poa annua* and *Reinwardtia indica* among the herbs.

Thus in the present survey of the vegetation of Manuni watershed 58 trees, 34 shrubs, 64 herbs and 12 climbers have been identified. Also, in recent years the

vegetation is under extreme stress, and of the several natural processes of evolution and change, human activities are more responsible to the degradation of quality and quantity of plant life and communities in the Himalaya (Gaur, 1999). This is also evident in the Manuni watershed, as anthropogenic activities like land clearing for agriculture, road cutting and initiation of hydropower projects are certainly bound to affect the vegetation of the study area. Therefore, development activity needs to be carefully planned and implemented so as to cause minimum damage to the freshwater ecosystem.

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