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Conservation status of threatened endemic flora of Western Himalayas

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Abstract

The present paper reports the findings of field surveys conducted over period (2011-2013) in 31 localities of North-West Pakistan for assessing the diversity of phanerogams. No comprehensive floristic studies have been carried out in line with standard methods and internationally accepted criteria of IUCN for categorization of threat level. A total of 1965 specimens were collected comprising of 512 taxa belonging to 107 families and 340 genera. In total 240 (47%) of the species were assessed as threatened. Assessment carried out for 161 species showed that 29 (18%) of the species were Critically Endangered (**CE**), 55 (34%) were Endangered (**EN**), 51 (32%) were Vulnerable (**VU**), and 26 (16%) were Near Threatened (**NT**). The remaining 272 species fell in the Least Concern (**LC**) category. Six of the **CE** species had less than 10 species in their respective area of occupancy **(AOO)**. The major threats to plant biodiversity in the study area are: collection for medicinal use, over-grazing, use as fuel wood or timber, land clearing and erosion, faced by 113, 93, 73, 72 and 61 species respectively. The study concludes that the dangers to species survival are 'clear and present'. The **CE** species require immediate attention keeping in view the human environment of high population growth rate, poverty, illiteracy and subsistence farming.

Key words: conservation, endemic, plant diversity, threatened, Western Himalayas.

1. Introduction

Biological diversity includes the diversity of ecosystems, species and genes, and the ecological processes that support them (Anonymous, 2004). It is necessary not only for human livelihoods and survival (Anonymous, 2009a), but also indispensable for ecosystem stability (Naeem et al., 1999). Loss of species could threaten the stability of the ecosystem services on which humans depend (McCann, 2000). Moreover, in an ecosystem complex, the diversity of plant species is one of the main factors supporting the diversity of other organisms (Myers et al., 2000).

Loss of biodiversity and extinction of species due to anthropogenic causes are global phenomena (Sala et al., 2000; Stork, 2010). In general terms, the threats to biodiversity have been identified by the acronym HIPPO (Habitat destruction, Invasive species, Pollution, Population and Over-exploitation) (Anonymous, 2009a). Area and ecosystem specific threats may include deforestation, habitat loss, degradation, soil erosion, over-grazing, fodder collection, introduction of invasive species, climatic changes etc. (Sudhersan et al., 2003). Biodiversity is facing multiple threats around the world. The severity of the threats is also increasing. This has resulted in the rate of extinction of species escalating to loss of one species per day. This rate is 1000-10,000 times faster than the estimated natural rate of extinction (Hilton-Taylor, 2000; Akeroyd, 2002). Among the 12914 species evaluated around the world, the percentage of species threatened with extinction is 68% as reported by IUCN for 2006. The number of species evaluated is itself very small as compared to the total number of plant species (Anonymous, 2008).

Geographical diversity and proximity to major centres of origin of plant species has gifted Pakistan with a rich biodiversity (Ali, 2008). The flora of Pakistan includes elements of six phytogeographic regions being, in order of importance, the Mediterranean, Saharo-Sindian, Euro-Siberian, Irano-Turanian, Sino-Japanese and Indian (Ali and Qaiser, 1986). Occurrence of more than 6000 vascular plant species has been reported in the country (Stewart, 1972).

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Many authors have endorsed the apprehension that biodiversity is under serious threat in Pakistan. They have also listed possible causes and remedies (Hamayun, 2007; Haq et al., 2010). In fact, Pakistan has been identified as having the world's highest rate of deforestation and hence, habitat loss (Anonymous, 2009b). Varying estimates of the number of threatened species have been published. For example the number of phanerogams under threat, have been estimated to be between 580-650 by Nasir (1991) and around 709 by Chaudhri and Qureshi (1991). Variation in such estimates is not un-expected because little work has been done so far on red listing of threatened taxa in accordance with the IUCN red list criteria (Alam and Ali, 2009). Ali and Qaiser (1986) have reported that 320 endemic species of phanerogams, mostly of Irano-Turanian or Sino-Japanese origin, are confined to the northern and western mountains of Pakistan. District Shangla, located in Himalayan mountain range, is well known for richness of its diverse flora (Ibrar, 2003; Khan, 2008). However anthropogenic activities may put most of the flora in district Shangla under threat of extinction in near future. General information has been reported by Shah and Farrukh (2012), Khan (2008), Ibrar (2003) and others. However, studies more in line with standard methods and the internationally accepted criteria of IUCN needs to be carried out to categorize plant species with regards to their conservation status and fully understand the nature and extent of threats. The present work is an attempt in this regard to document the conservation status of plants of district Shangla according to IUCN red list categories and criteria.

The administrative district of 'Shangla' is located in the north-eastern part of the Khyber Pakhtunkhwa province of Pakistan between 34°-31" to 33°-08" N latitudes and 72°-33" to 73°-01" E longitudes (Figure 1).

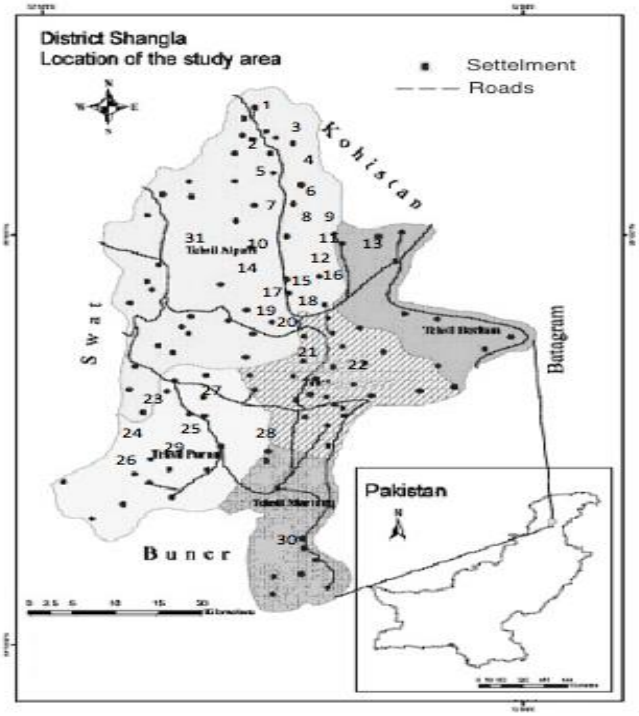

Figure 1. Map of the study area. Numbers (1-31) on the map show the localities visited for the survey. Corresponding names of localities are given in Table 2

Spread over an area of 1,586 km^2 within the western extremities of the great Himalayan range, Shangla district consists of small valleys, hillocks, and thick forests. District Shangla has a population of 434, 563 persons, which is increasing at a very high rate of 3.27% per year (Anonymous, 1998; Khan, 2008). Elevation from sea level in district Shangla varies from 900 masl (at Puran) to 4000 masl (at Takh Danda) (Khan 2008). The winter season remains extremely cold in the upper half of the district while it is moderate in the lower half. Precipitation in the temperate parts occurs both as rain and snow. The total cultivated area in the district is 41727.5 ha. However, most of the cultivated land i.e. 38652.6 ha (98%) is rainfed whereas only 3075 ha (2%) is irrigated. The area designated as 'forests' is spread over 39865.6 ha (Khattak, 1984). Main summer crops are maize, beans, rice and vegetables. Wheat is an important winter cereal along with normal and off-season vegetables such as radish, turnip and peas (Khan, 2001).

Most of the forests of district Shangla fall under Moist Temperate category (Champion et al., 1965) of the internationally known Western Himalayan moist temperate ecology. On the basis of available indicator species, the district Shangla forests can further be classified into the four categories. *Abies pindrow*, *Picea smithiana*, *Pinus wallichiana* and *Qurercus* forests are situated in Alpuri, Kana, Lilowni, Bazarkot, Opal, Shang and to some extent in the upper reaches of Chakaisar, Puran and Martung. *Pinus wallichiana* forests are situated in Bazarkot, Lilowni and Alpuri blocks. *Pinus roxburghii* forests are vigorous on cooler aspects (such as in Chakesar area) while they are stunted and malformed on hotter aspects as in the Makhozi and Martong areas. Mountain peaks areas are occupied by *Dry sub-*

tropical Qurercus forests. The major forest tree species located in these areas include *Abies pindrow*, *Picea smithiana*, *Pinus wallichiana*, *Pinus gerardiana*, *Cedrus deodara* etc (Khattak, 1984).

A preliminary analysis of the soil texture showed that it is sandy loam in nature with pH ranging from 7.7 to 8.2. The organic content of the soil ranges from 0.96 to 1.20%. However different soil parameters are expected to show variation with altitude.

2. Materials and methods

Field studies were carried out for three consecutive years i.e. 2011 (March 15 to Nov 10), 2012 (March 20 to Nov 5) and 2013 (April 3 to Aug 15) using the standard IUCN criteria. A total of 31 localities, representing the entire district Shangla, were visited (Tab. 1). The localities were selected according to the variety of habitat and climatic conditions as identified by studying the Google earth maps, topographic sheets and personal observation. None of the localities had previously been explored mainly because of their inaccessibility. The plain areas were studied in March-June while mountainous areas were studied from July to the end of September as the areas are either snowbound or the plants are not in the flowering stage in the rest of the year. Plant specimens were collected along with extensive field notes including voucher specimens, botanical names, common name, habit, habitat, life form, altitude etc. Effect of various anthropogenic threats i.e. deforestation, habitat loss, degradation, erosion, grazing, medicinal usage etc. on the flora were also studied. Identification of voucher specimens was carried out with the help of Flora of Pakistan (Nasir and Ali, 1970 – 1979; Ali and Nasir, 1990 – 1992; Ali and Qaiser, 1992 –2012; Nasir and Ali, 1980-1989) and *Flora Iranica* (Rechinger, 1957-2001). Voucher specimens were pressed, poisoned, mounted on standard sized herbarium sheets and deposited in duplicate in the Herbarium of Hazara University, Mansehra-Pakistan. Population size **(PS)** of the species was assessed by counting mature individuals in a particular locality. Area of Occupancy **(AOO)** was calculated by the presence of taxa in a grid of 4 Km^2 areas. Extent of Occurrence **(EOO)** was worked out by drawing a polygon around all localities. For data analysis IUCN red list categories and criteria were applied (Anonymous, 2001).

3. Results

Documenting the basic patterns of biodiversity and accurately determining the priority areas are the first steps for conservation studies (Ture and Bocuk, 2010). The present study was carried out in three consecutive years (2011 to 2013) to assess the diversity of phanerogams of district Shangla and to categorize the threatened species. The main objective of the survey was to collect data and information for assessing the conservation status of the endemic phanerogams in accordance with the IUCN Red Data List: Categories and Criteria version 3.1. A total of 1965 specimens were collected from 31 locations. The specimens comprised of 512 taxa belonging to 107 families and 340 genera. It was noted that among the total 512 taxa, 240 species (47%) fell into one or the other threat categories. The remaining species were categorized as Least Concern **(LC)**. Within the **LC** category, 133 species were common and 139 species were very common (Figure 2) (detail for individual species is in Table 2). Conservation status assessment was scored for 161 plant species. Among these species 29 (18%) were Critically Endangered **(CE)**, 55 (34%) were Endangered **(EN)**, 51 (32%) were Vulnerable **(VU)**, and 26 (16%) species were Near Threatened **(NT)**. Biodiversity is under threat throughout the world (Kaharman et al., 2011) and Pakistan is no exception. Ecological examinations, the habitat features of the plants in areas opened to tourism, in-situ conservation strategy are obligatory (Uysal et al., 2016). The severe threats to biodiversity in Pakistan have been recorded by many researchers. It has been estimated that several valuable species may have disappeared without even being documented while the status of others have worsened in the face of variety of threats reported by (Hamayun, 2007; Anonymous, 2009b; Haq et al., 2010).

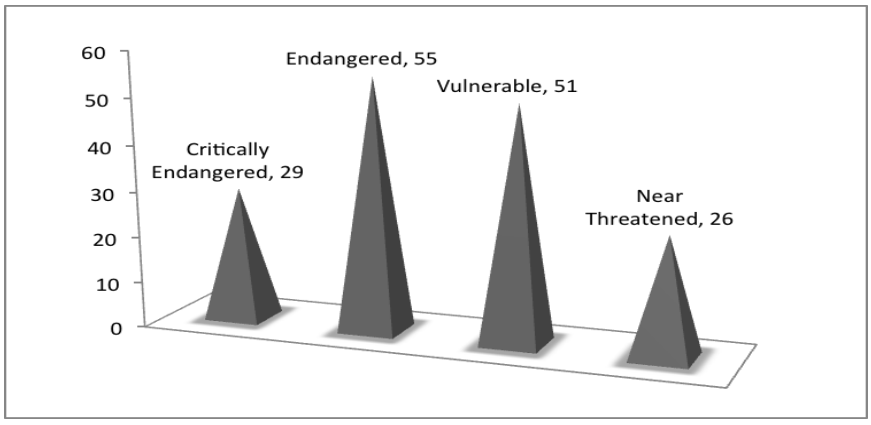

Figure 2. Conservation status of plant species in threat categories (IUCN Red List criteria and categories) in district Shangla, Western-Himalayas, Pakistan

Table 2. Conservation status of plant species and major threats to biodiversity of flowering plants in Shangla district, Pakistan

S. #	Botanical Name	V/Name	PS	AOO. Km²	EOO. Km²	Various Threats					C.S
						A	B	C	D	E	
1.	*Abies pindrow* Royle	Achar	*4707*	*480.3*	*933.5*	+	+	+	-	+	**EN**
2.	*Acacia modesta* Wall.	Palosa	*313*	*43.2*	*877*	-	+	+	+	+	**EN**
3.	*Aconitum chasmanthum* Stapf ex Holmes	Zahar	*18976*	*444*	*778*	+	-	-	+	-	**NT**
4.	*Aconitum heterophyllum* Wall.	Sarba wale	*16755*	*322*	*641*	+	-	-	+	-	**NT**
5.	*Aconitum rotundifolium* Kar. & Kir	Sarba Jarai/Sarba Zailay	*8687*	*155*	*741*	+	-	+	+	-	**VU**
6.	*Aconitum violaceum* Jacq. ex Stapf.	Zahar Mora	*15343*	*243.2*	*625*	+	-	-	+	-	**NT**
7.	*Acorus calamus* L.	Skha waja	*134*	*91.2*	*762*	+	-	-	+	-	**EN**
8.	*Aesculus indica* (Wall. ex Camb.) H. K. F.	Jawaz	*2231*	*187*	*721*	+	+	-	-	+	**VU**
9.	*Agrimonia eupatoria* L.	Da Obo jarai	*5*	*52*	*901*	+	-	-	+	-	**CE**
10.	*Ailanthus altissima* (Mill.) Swingle	Backyanra	*5886*	*186*	*875*	-	+	+	-	+	**VU**
11.	*Ajuga bracteosa* Wall. ex Benth.	Da Ghra Buti	*24343*	*344*	*621*	+	-	+	+	+	**NT**
12.	*Ajuga perviflora* Benth.	Da Sam Boty	*23432*	*311*	*442*	+	-	+	+	+	**NT**
13.	*Alnus nitida* (Spach) Endl.	Gerai	*245*	*342.5*	*663*	-	+	+	-	+	**EN**
14.	*Andrachne cordifolia* (Wall. ex Deecne.) Muell. Arg.	Spin krachay	*6765*	*564*	*783*	-	+	-	+	+	**VU**
15.	*Anemone tetrasepala* Royle	Kadoo	*13772*	*187.4*	*656*	+	-	-	+	-	**NT**
16.	*Aquilegia nivalis* Falc. ex Jackson	Deesi zahar	*4542*	*322*	*643*	+	-	-	+	+	**VU**
17.	*Arisaema Jacquemontii* Blum, Rumphia	Mar jarai	*6765*	*164*	*863*	+	-	-	+	-	**VU**
18.	*Arisaema utile* Hook. F. ex Schott	Marjarai	*2431*	*352.2*	*1060*	+	-	+	-	-	**EN**
19.	*Artemisia scoparia* Waldst & Kit.	Jawkai/Jaa	*243*	*68.4*	*634.4*	+	+	-	+	-	**EN**
20.	*Artemisia vulgaris* L.	Da Ghra Tarkha	*23321*	*233.2*	*531.2*	+	-	+	+	-	**NT**
21.	*Asclepias cusassavica* L.	Mrach Botai	*54332*	*331*	*823*	+	-	-	+	_	**NT**
22.	*Asparagus filicinus* Buch.-Ham. ex D. Don	Shal gwatai	*4553*	*156*	*734*	+	+	-	+	-	**VU**
23.	*Asparagus officinalis* L.	Tindorai	*2312*	*242*	*875.1*	+	-	-	+	-	**EN**
24.	*Asparagus racemosus* Willd.	Nori Alam	*34*	*8*	*431*	+	+	-	+	-	**CE**
25.	*Astragalus grahamianus* Royle ex Benth.	Ghwarakai	*23111*	*332*	*453*	+	-	+	-	+	**NT**
26.	*Astragalus pyrrhotrichus* Boiss.	Ghwarakai	*24422*	*411*	*564*	+	-	+	-	+	**NT**
27.	*Astragalus retamocarpus* Boiss. & Hohen.	Zahar Botai	*23*	*12*	*345*	+	-	+	-	+	**CE**
28.	*Berberis calliobotrys* Bien. ex Koehne	Ghat Kwarai	*1139*	*456*	*632*	+	+	+	-	-	**EN**
29.	*Berberis lycium* Royle	Tor Kwarai	*313*	*253*	*865*	+	+	-	-	-	**EN**
30.	*Berberis pseudumbellata* Parker	Tor Kwarai	*6764*	*163*	*854*	+	+	-	-	-	**VU**
31.	*Bergenia ciliata* (Haw.) Strnb.	Zakhm Hayat	*9797*	*353*	*897*	+	-	-	+	-	**VU**
32.	*Buxus wallichiana* Baillon	Shamshad	*4*	*51.2*	*453.4*	-	+	+	-	+	**CE**
33.	*Caesalpinia decapetala* (Roth) Alston	Jara	*367*	*8*	*651*	+	+	-	-	+	**EN**
34.	*Campanula tenuissima* Dunn	Spin Gulai	*321*	*342.3*	*1231*	-	-	+	+	-	**EN**
35.	*Carthamus oxycantha* M. Bieb.	Kareza	*221*	*6.4*	*645*	+	+	-	-	+	**CE**
36.	*Cedrella serrata* Royle	Barabro	*11132*	*211*	*323*	-	+	+	-	+	**NT**
37.	*Cedrus deodara* (Roxb. ex D. Don) G. Don	Ranzara	*431*	*6*	*76.4*	+	+	-	-	+	**CE**
38.	*Celtis caucasica* Willd.	Tagha	*231*	*453.4*	*822*	+	+	+	-	+	**EN**
39.	*Cichorum intybus* L.	Han	*8965*	*131*	*976*	+	-	+	+	+	**VU**
40.	*Clematis connata* DC.	Chinjanwalla	*2433*	*343.4*	*1124*	+	+	-	-	-	**EN**
41.	*Clematis grata* Wall.	Tora Zela	*56*	*6*	*89*	+	+	-	-	-	**CE**
42.	*Clematis montana* Buch-Ham.ex DC.	Zelanga	*17673*	*231.2*	*462*	+	-	-	-	-	**NT**
43.	*Clematis orientalis* L.	Ziar Gulai	*12211*	*112.1*	*245*	+	-	-	-	-	**NT**
44.	*Colchicum luteum* Baker	Sorranjan Talkh	*2227*	*324*	*3421*	+	-	+	-	+	**EN**
45.	*Colebrookea oppositifolia* Sm.	Chaghgi panra	*12121*	*422*	*878*	+	+	-	-	+	**NT**
46.	*Corydalis govaniana* Wall.	Mamera	*6765*	*321*	*832*	+	-	-	+	-	**VU**
47.	*Cotoneaster microphylla* Wall. ex Lindl.	Kharawa	*1314*	*452.3*	*732*	-	+	+	-	+	**EN**
48.	*Cotoneaster nummularia* Fisch. & Mey.	Mamanra	*1312*	*342.3*	*636*	-	+	+	-	+	**EN**
49.	*Crataegus sonogarica* G. Koch	Tampasa	*51*	*7*	*78*	+	+	-	-	+	**CE**
50.	*Dactylorhiza hatagirea* (D. Don) Soo	Tali panja	*1123*	*12.3*	*98.2*	+	-	+	+	+	**CE**
51.	*Dalbergia sissoo* Roxb.	Shawa	*312*	*153.4*	*532*	+	+	+	-	+	**EN**
52.	*Daphne mucronata* Royle	Da barn Leghonai	*2322*	*231*	*897*	+	+	-	+	+	**EN**
53.	*Daphne papyracea* Wall. ex Steud.	Leghonai	*14433*	*233.2*	*342*	+	+	-	+	+	**NT**
54.	*Debregeasia salicifolia* (D. Don) Rendle	Ijlai	*321*	*142*	*813*	+	+	-	-	+	**EN**
55.	*Delphinium rolyei* Munz	Lajwand	*613*	*231*	*864.6*	+	-	-	+	-	**EN**
56.	*Desmodium elegans* DC.	Shna lakhta	*331*	*52*	*732*	-	+	-	+	+	**EN**
57.	*Diospyros kaki* L.	Sor Amlook	*7868*	*186*	*862*	-	+	-	-	-	**VU**
58.	*Diospyros lotus* L.	Toor Amlook	*2412*	*453.2*	*1352*	-	+	+	-	+	**EN**
59.	*Dipsacus inermis* Wall.	Dad botai	*14322*	*231.1*	*634*	-	-	-	+	-	**NT**
60.	*Eryngium coeruleum* M-Bieb.	Manzari Mangul	*13221*	*333.2*	*432*	+	-	+	+	-	**NT**

Table 2. Continued

61.	*Euphorbia wallichii Hook*. F.	Zahar Botai	*235*	*56.7*	*952*	+	-	-	-	-	**EN**
62.	*Euphrasia himalayica* Wettst.	Stargai	*123*	*16.5*	*854.4*	-	-	+	+	-	**EN**
63.	*Ficus palmata* Forssk.	Inzar	*5664*	*321*	*811*	-	+	-	-	+	**VU**
64.	*Ficus racemosa* L.	Ormal	*1311*	*355.4*	*980*	-	+	-	-	+	**EN**
65.	*Fritillaria roylei* Hook.	Asli Noory Alam	*42*	*9*	*93*	+	-	+	+	-	**CE**
66.	*Gentianodes cachemirica* (Decne.) Omer, Ali & Qaiser.	Tora Bankera	*7866*	*199*	*453*	+	-	-	+	-	**VU**
67.	*Gentianodes olivieri* (Griseb.) Omer, Ali & Qaiser.	Mrach Botai	*1412*	*321.4*	*676.87*	+	-	+	+	+	**EN**
68.	*Geranium wallichianum* D. Don ex Sweet	Rati jarh	*6754*	*132*	*751*	+	-	-	+	-	**VU**
69.	*Geum elatum* Wallich	Spensar boti	*233*	*453*	*876.7*	+	-	-	+	-	**EN**
70.	*Girardinia palmata* Blume	Taparh	*8987*	*433*	*745*	-	+	-	+	+	**VU**
71.	*Hedera nepalensis* K. Koch	Zelai	*211*	*312*	*1121*	+	+	-	-	-	**EN**
72.	*Hypericum dyeri* Rehder	Unknown	*6854*	*564*	*687*	+	-	-	+	+	**VU**
73.	*Hypericum oblongifolium* Choisy	Ziar gulai	*121*	*342*	*1193*	+	-	+	-	-	**EN**
74.	*Hypericum perforatum* L.	Shin Chai	*4533*	*175*	*977*	+	-	-	+	-	**VU**
75.	*Impatiens edgeworthii* Hook. F.	Atrang	*34322*	*332*	*443*	+	-	+	-	+	**NT**
76.	*Inula grandiflora* Willd.	Kot	*15*	*8.9*	*87*	+	-	+	+	+	**CE**
77.	*Ipomoea hederaceae* (L.) jacq.	Prewatai	*5754*	*186*	*976*	+	-	-	+	+	**VU**
78.	*Ipomoea purpurea* (L.) Roth	Zelai	*5665*	*155*	*876*	+	-	-	+	+	**VU**
79.	*Iris germanica* L.	Sosan	*23*	*7*	*78.6*	+	-	+	+	-	**CE**
80.	*Iris hookeriana* R. C. Foster	Turai	*41*	*17*	*68.9*	+	-	-	+	-	**CE**
81.	*Ixiolarion tataricum* (Pall.) Herb.	Shin Gulai	*15433*	*423.2*	*732*	+	-	-	+	+	**NT**
82.	*Juglans regia* L.	Ghuz	*232.3*	*432.3*	*521*	+	+	-	-	+	**EN**
83.	*Jurinea dolomiaea* Boiss.	Sharshamai	*133*	*631*	*632*	+	-	-	+	-	**EN**
84.	*Kickxia ramosissima* (Wall.) Janchen	Unknown	*1237*	*42.6*	*1057*	-	-	+	+	-	**EN**
85.	*Lysimachia ch**en**opodioides* Watt ex HK. F.	Unknown	*2313*	*233.4*	*1242*	-	-	+	+	-	**EN**
86.	*Lysimachia japonica* Thunb.	Ziar Gulai	*5633*	*111*	*897*	-	-	-	+	-	**VU**
87.	*Maytenus royleanus* Wall.	Soor azghai	*13221*	*532*	*933*	-	+	-	-	+	**NT**
88.	*Maytenus wallichiana* (Springe) Raju & Bull.	Bampor	*14321*	*421*	*643*	+	+	-	-	+	**NT**
89.	*Melia azedarach* L.	Tora bakiana	*1213*	*423.8*	*921*	+	+	+	-	+	**EN**
90.	*Morus nigra* L.	Toot	*8987*	*656*	*866*	-	+	-	-	+	**VU**
91.	*Olea ferruginea* Wall. ex Aitch.	Khona	*1421*	*432.3*	*921*	+	+	-	-	+	**EN**
92.	*Origanum vulgare* L.	Narai Shamakai	*14331*	*453*	*732*	+	-	+	+	-	**NT**
93.	*Otostegia limbata* (Benth.) Boiss.	Spin Azghai	*6675*	*232*	*764*	+	+	-	-	+	**VU**
94.	*Paeonia emodi* Wall. ex Royle	Mamekh	*1435*	*612*	*1155*	+	-	-	+	-	**VU**
95.	*Parrotiopsis jacquemontiana* (Decne.) Rehder	Beranj	*1111*	*121*	*1121*	-	+	-	+	+	**EN**
96.	*Pedicularis punctata* Dec.	Har gulai	*1256*	*7*	*68*	-	-	+	+	-	**CE**
97.	*Pedicularis pyramidata* Royle	Marano botai	*34321*	*321*	*343.2*	+	-	-	+	-	**NT**
98.	*Physalis divaricata* D. Don	Mangotai	*34*	*9*	*891*	+	-	+	-	+	**CE**
99.	*Picea smithiana* (Wall.) Boiss.	Chokat/Rawn	*9411*	*653*	*1142*	+	+	-	-	+	**VU**
100.	*Pinus gerardiana* Wall. Ex Lamb.	Chalgoza	*1131*	*213.5*	*1121*	-	+	-	-	+	**EN**
101.	*Pinus roxburghii* Sargent	Nakhtar	*6743*	*311*	*743*	-	+	-	+	+	**VU**
102.	*Pinus wallichiana* A. B. Jackson	Sruf	*8222*	*342*	*956.6*	+	+	-	-	+	**EN**
103.	*Platanus orientalis* L.	Chinar	*311*	*233.5*	*953*	-	+	-	-	+	**EN**
104.	*Pleurospermum brunonis* DC. Clarke	Asila Shangatai	*6381*	*231*	*1135*	+	+	-	-	-	**EN**
105.	*Podophyllum hexandrum* Royle.	Asila Kakora	*218*	*165.6*	*1321.6*	+	-	-	+	-	**EN**
106.	*Polygonatum gemniflorum* Decne.	Margha Jarai	*213*	*433.5*	*742*	+	-	+	+	-	**EN**
107.	*Polygonatum multiflorum* (L.) All.	Noory Alam	1612	*7*	*851*	+	-	+	+	-	**EN**
108.	*Polygonatum verticillatum* (L.) All.	Nori Alam	*234*	*342.6*	*533.7*	+	-	+	+	-	**EN**
109.	*Potentilla curviseta* Hook.F.	Unknown	*132*	*8*	*95*	-	+	-	+	-	**CE**
110.	*Potentilla grisae* Juz.	Tora buti	*2431*	*7*	*78*	+	-	-	+	-	**CE**
111.	*Potentilla sericophylla* Parker	Unknown	*19*	*9*	*56*	-	+	-	+	-	**CE**
112.	*Potentilla supina* L.	Ziar Gulai	*67*	*8.5*	*851.3*	+	-	+	+	-	**CE**
113.	*Pseudomertensia moltkioides* (Royle ex Benth.) Kazmi	Desi Bangera	*34*	*7.5*	*981*	+	-	+	+	-	**CE**
114.	*Pteris vitata* L.	Tokhi Later	*5775*	*297*	*687*	+	-	-	+	-	**VU**
115.	*Pyrus pashia* Buch-Ham ex D.Don	Tangai	*7878*	*564*	*874*	-	+	-	-	+	**VU**
116.	*Quercus baloot* Griff.	Tor Banj	*5222*	*324*	*675*	-	+	-	-	+	**VU**
117.	*Quercus dilatata* Lindl.	Tor Banj (Serai)	*5421*	*231.6*	*786*	-	+	-	-	+	**VU**
118.	*Quercus glauca* Thunb.	Banj	*421*	*435.5*	*675*	-	+	-	-	+	**EN**
119.	*Quercus incana* W. Bartram	Spin banj	*6313*	*342.5*	*757*	+	+	+	-	+	**EN**
120.	*Quercus semecarpifolia* Sm.	Mer/ Kaner	*132*	*8*	*56*	-	+	+	-	+	**CE**
121.	*Randia dumatorum* Lam.	Mainpal	*7876*	*145*	*877*	-	-	-	+	-	**VU**
122.	*Reinwardtia trigyna* (Roxb.) Plan	Unknown	*4532*	*197*	*871*	-	-	+	-	+	**VU**
123.	*Rhodiola wallichiana* (Hook) S.H. Fu.	Da Ghra Warkharai	*223*	*342.4*	*3313*	+	-	-	+	-	**EN**
124.	*Rhododendron arboreum* Smith	Gul Namer	*6*	*8*	*786*	+	+	-	-	-	**CE**

Table 2. Continued

125.	*Rhododendron hypenanthum* Balf. F.	Gul Namer	*8*	*5.3*	*1256*	-	-	-	+	-	**CE**
126.	*Rhus punjabensis* J. L. Stewart ex Brindle	Tetrai	*45*	*321.4*	*1121*	+	+	-	-	+	**CE**
127.	*Rhus succedanea var. himalaica* J. D. Hooker	Rakhkal	*5*	*8*	*453.6*	-	+	+	-	+	**CE**
128.	*Robinia Pseudo-acacia* L.	Kikar	*11333*	*632*	*864*	-	+	-	-	+	**VU**
129.	*Rosa damascena* Miller.	Pulwari	*6775*	*132*	*889*	+	+	-	+	+	**VU**
130.	*Rosa webbiana* Wall. ex Royle	Sadbar Gul	*8976*	*142*	*878*	-	+	-	+	-	**VU**
131.	*Rubus ellipticus* Sm.	Karwara	*8977*	*122*	*987*	+	+	-	+	+	**VU**
132.	*Rubus fruiticosus* Agg.	Karwara	*3553*	*333*	*753*	+	+	-	+	+	**VU**
133.	*Rubus sanchtus* Schreber	Bagana	*1332*	*575*	*676*	+	+	-	+	+	**VU**
134.	*Salix tetrasperma* Roxb.	Wala	*5654*	*165*	*675*	-	+	-	+	-	**VU**
135.	*Salvia lanata* Roxb.	Keyanr	*6865*	*241*	*986*	+	-	-	+	-	**VU**
136.	*Salvia moocroftiana* Wall.	Kharghwag	*7876*	*132*	*724*	+	-	-	+	-	**VU**
137.	*Salvia nubicola* Wall. ex Sweet	Bakara	*5777*	*241*	*967*	+	-	+	+	-	**VU**
138.	*Sarcococca saligna* (D. Don) Müll. Arg.	Ladnr	*12111*	*534*	*976*	+	+	+	+	+	**VU**
139.	*Saussurea albescens* (DC.) Sch. Bip.	Khardag	*5111*	*631*	*864*	+	-	+	+	-	**EN**
140.	*Saxifraga flagellaris* Willd.	Mergaya	*17876*	*1311*	*822*	+	-	+	+	-	**NT**
141.	*Saxifraga parnassifolia* D.Don	Ziar gulai	*2421*	*231*	*786*	+	-	-	+	-	**EN**
142.	*Saxifraga stenophylla* Royle	Mergaya	*16755*	*532*	*678*	+	-	+	+	-	**NT**
143.	*Scilla griffithii* Hochr.	Shin Gulai	*16755*	*1231*	*765*	-	-	+	+	+	**NT**
144.	*Sedum oreades* (Decne.) Raym-Hamet	Ziar gulai	*1211*	*9*	*1245*	-	-	+	+	-	**EN**
145.	*Sibbaldia procumbens* L.	Ziar Gulai	*123*	*9*	*78*	+	+	-	+	-	**CE**
146.	*Skimmia laureola* Franch.	Nazar panra	*2435*	*644*	*1122.5*	+	+	-	-	-	**VU**
147.	*Stachys emodi* Hedge	Spin gula saag	*6754*	*165*	*821*	+	-	-	+	-	**VU**
148.	*Taxus fauna* Nan Li & R. R. Mill	Banya	*4*	*5.6*	*87.8*	+	+	+	-	-	**CE**
149.	*Teucrium stocksianum* Boiss.	Kwande botai	*234*	*6*	*67.7*	+	-	-	+	-	**CE**
150.	*Trillium govanianum* Wall. ex Royle	Lal Dana	*4543*	*175*	*632*	+	-	-	+	-	**VU**
151.	*Trollius acaulis* Lindle.	Deesi zhar	*33*	*23.2*	*1211*	+	-	+	+	-	**CE**
152.	*Tussilago farfara* L.	Funjiwam	*6787*	*423*	*859*	-	-	+	+	-	**VU**
153.	*Urtica dioca* L.	Sezonkai	*9879*	*566*	*745*	-	-	+	-	-	**VU**
154.	*Verbascum thapsus* L.	Khardage	*1354*	*6.5*	*667.5*	+	-	+	+	-	**EN**
155.	*Viburnum grandiflorum* Wall. ex DC.	Sumangal	*7865*	*175*	*786*	+	+	-	+	-	**VU**
156.	*Viola biflora* L.	Da Ghra sanchl	*7886*	*385*	*764*	+	-	-	+	-	**VU**
157.	*Viscum album* L.	Shishar Meva	*213*	*432*	*897*	-	-	-	-	-	**EN**
158.	*Viscum cruciatum* Sieber ex Spring.	Melma	*213*	*342.6*	*779*	+	-	-	-	-	**EN**
159.	*Woodfordia fruiticosa* (L.) S. Kurz.	Dhaur	*8765*	*563*	*897*	-	-	+	-	+	**VU**
160.	*Wulfenia amherstiana* Benth.	Warokai Makanpath	*231*	*231.4*	*746*	+	-	+	+	-	**EN**
161.	*Zanthxylum armatum* DC.	Dambara	*453*	*341.6*	*897*	+	+	+	-	+	**EN**

KEY: CE= Critically Endangered, EN= Endangered, VU= Vulnerable, NT= Near Threatened, A= Medicinal use, B= As Fuel wood, C=Erosion, D=Grazing, E= Clearing land for Agriculture, EOO= Extent of occurrence, AOO= area of Occupancy, PS= Population Size, CS= Conservation Status

The species that require immediate attention are the **CE** species, of which 29 were identified in the present study. A closer look at the list of the **CE** species shows that the **PS** of six species is less than 10 individuals in their respective **AOO** in limited **EOO**. The number of individuals recorded for *Agrimonia eupatoria* L., *Buxus wallichiana* Baillon. *Rhododendron arboreum* Smith. *Rhododendron hypenanthum* Balf., *Rhus succedanea var. himalaica* Hooker. *Taxus fauna* Nan Li. and Mill. was only 5, 4, 6, 8, 5 and 4 respectively. It is obvious that these species may be at the verge of extension if their **PS, AOO** and **EOO** values are similar or worse in the other areas too.

The number of species assessed as **EN** was 55 (34%) among the 161 species evaluated for their conservation status, thus **EN** species constituted the biggest category of the threatened species. *Acorus calamus* L. *Acorus calamus* L. and *Jurinea dolomiaea* B. had only 134, 123 and 133 individuals respectively in their **AOO**. So it is apprehended that their category may have to be revised downward to **CE** if the threats persist and conservation measures are not adopted. According to IUCN, **VU** species is a population of those plants, which is unprotected against the threats (Anonymous, 2008). In the present study 51 species (32%) were categorized as **VU**, which are all, faced with multiple threats. The **VU** plants of the area include important medicinal, fodder, timber and fruit species (Table. 2). Twenty-six species (26) were identified as **NT**.

Biodiversity is indispensable for eco-system stability in general but local declines in biodiversity are even more dramatic than global declines because many ecosystem processes are sensitive to declines in biodiversity (Naeem et al., 1999). Specific threats to biodiversity important in the local context have been reported by Hamayun (2007) and Haq et al. (2010). The present work shows that anthropogenic activities of collection for medicinal use, over-grazing, use as fuel wood or timber, land clearing for agriculture and erosion are the major threats to plant biodiversity in the study area. These major threats are faced by 113, 93, 73, 72 and 71 species respectively (Figure 3). It is clear that most of the species are faced with multiple threats with possible multiplier effects. The major threats to biodiversity reported for areas having socio-economic and ecological environments similar to Shangla, are supportive of our findings. Over-exploitation (for medicine, timber, firewood etc), loss of habitat (increase in population, deforestation, erosion etc.),

non-scientific harvesting, over-grazing etc. have been reported as the major reasons for loss of species in the district Swat and district Battagram which are adjacent to Shangla (Hamayun 2007; Haq et al., 2010). Land levelling and dependency, which increase the rate of deforestation, on forests have been identified as the major threats to biodiversity in the Himalayan by Shaheen et al. (2011), Ahmad et al. (2006) and Hamayun et al. (2006).

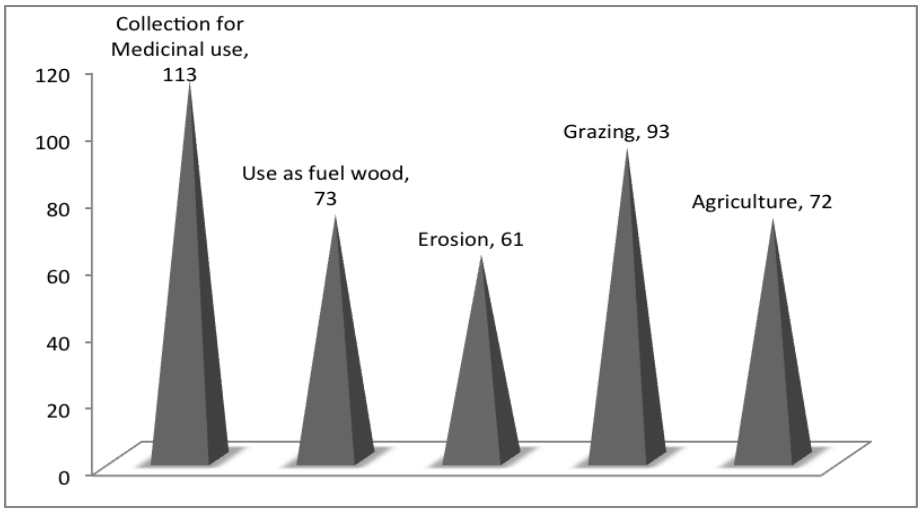

Figure 3. Number of species versus nature of threat studied in Western-Himalayas, Pakistan

In district Shangla the tree and shrub flora are under extreme biotic stress as the same are being cut down for use as fuel wood and timber or for clearing the land for agriculture. No new planting has been observed in the area to replace the trees, which are cut down. Similar results were recorded by Hamayun (2005) for Utror and Garbal Valleys of Swat, Pakistan. Cutting of trees for fuel wood prior to snowy seasons and Agriculture land extension are the root cause of deforestation because before the start of harsh and snowy season the local inhabitants cut the forest trees for fuel wood. This becomes a major cause for eradication of valuable species like *Cedrus deodara*, *Pinus wallichiana*, *Pinus gerardiana etc* (Khan, 2008). Ghazanfar and Osborne (2010) had not only recorded over-grazing as a major threat to biodiversity as few species are tolerant to the prevailing pattern of grazing which results grazing in poor regeneration. Poor regeneration after grazing was also recorded in the present study except for some difficult to access areas such as i.e. Takh banda, Lawder Medan, Papeno Banda etc., which may be due to lower grazing frequency in the areas. This pattern is repeated in many parts of the country and contribute to Pakistan having the world's highest rate of deforestation and hence, habitat loss (Anonymous, 2009b). The second group of plants that faces major threats to the survival of its members in the study area is the group comprising of plants of medicinal and aromatic value. Among the 113 species that are threatened by over-harvesting in the area, most are herbs of medicinal value. The diverse flora of Pakistan includes 400-600 species, which are medicinally important, and, according to one estimate, about 400 species were traded in different drug markets of the country (Nasir and Ali 1972; Hamayun et al. 2005). Located in the general area from which most of the medicinal plants are collected for sale in domestic as well as export markets (Sher et al., 2014), the medicinal plants of Shangla are under extreme exploitative pressure.

4. Conclusions and discussion

Medicinal plants face a high risk of extinction in all those parts of the world where people are most dependent on them for health care and income from wild collection – namely Africa, Asia, the Pacific and South America (Ture and Bucuk, 2010). Due to high incidence of poverty in Shangla district, agriculture of the area is mostly subsistence type of farming. Due to lack of job opportunities in trade or industry, the people resort to collection of medicinal plants not only for local medicinal use, but also for income support by sale to local traders. A similar pattern of mostly informal gathering and collection has been reported from the adjoining district of Swat (Sher and Hussain, 2009). The local traders are linked to national and international traders in a complex pattern (Sher et al., 2014). The collection and processing however are carried out in an unscientific manner so the loss to the environment is multiplied but benefit to the collectors or local traders remains minimum. For example the whole plant is needlessly uprooted instead of harvesting the useable part in moderate quantity (Schippmann et al., 2002). The collection activity, mostly by women and children, continues throughout the year (Haq et al., 2010) but the major damage occurs during summer and spring seasons when the plants are in luxuriant growth. The low income and high poverty level contributes to the phenomenon of over harvesting. Linkage between environmental degradation and poverty has been reported to exist (Anonymous, 2009b) and appears to be at play in the study area too. Most of the local people are unaware about the importance of endemic plants and the conservation issues related to them. Precious medicinal plants are treated by local people

unwisely and are being collected for consumption in unsustainable quantities. That is why many of the species are either on the red list or steadily moving in that direction (Khan, 2008).

It is concluded that the rich plant biodiversity of district Shangla is threatened by a variety of factors including over harvesting of medicinal plants, grazing, use as fuel wood/timber, clearing of land for agriculture and erosion. The threats are similar to those reported by other researchers for ecologically and economically similar areas. The scale of the danger to biodiversity can be gauged from the fact that the number of **CE** species has been recorded to be 29 among the 161 species evaluated. Six species in this category have less than 10 mature individuals in their respective **AOO**. Most of the species are facing multiple threats with possible multiplier effects. The **CE** species require immediate attention for their conservation in a human environment of population pressure, poverty and low level of literacy/awareness. Organizing and educating the community and an active role by the government/ NGO's under these circumstances has been proposed by many researchers. It is further proposed that in-situ and ex-situ conservation of plant species in district Shangla may be studied and adopted especially in the form of cultivation of high value medicinal and aromatic plants as crops such as *Morchella spp*. This will not only reduce the pressure on natural resources but also increase supply of the species and improve income of the local farmers. Cultivation of species as crops will augment the income of small farmers and rural communities with important lessons and package of good practices for other areas. So far little research has been carried out to see the potential of suitable medicinal or aromatic species to be cultivated as crops in the Shangla area.

Abbreviations: AOO, area of occupancy; CE, Critically Endangered; EN, Endangered; EOO, Extent of Occurrence; HIPPO, Habitat destruction, Invasive species, Pollution, Population and Over-exploitation; LC, Least Concern; NT, Near Threatened; PS, population size; VU, Vulnerable

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