

# Diversity, Indigenous Uses, Threat Categorization and Conservation Prioritization of Medicinal Plants: A Case Study from Himachal Pradesh, India

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## Abstract

Mountains are among the most fragile environments on this planet. They are rich source of biodiversity, water, providers of ecosystem services on which downstream communities (both regional and global) rely. They are home to some of the world's most threatened and endemic species (including medicinal plants), as well as to some of the poorest people, who are dependent on the biological resources. The worth of medicinal plants in regular healthcare practices provides clues to latest areas of research and in biodiversity conservation is now glowing. However, information on the uses of plants for medicine is deficient from interior areas of Himalaya. Keeping this in view, the present study has been conducted to study the diversity, indigenous uses, threat categorization and conservation prioritization of medicinal plants in Banjar Valley of Kullu district in Himachal Pradesh, North Western Himalaya. A total of 357 species of medicinal plants belonging to 98 families and 237 genera were recorded and used by the inhabitants of the area. These medicinal plants comprise of 27 trees, 269 herbs, 54 shrubs, 02 climber and 05 ferns. From the total, 193 medicinal plants were native, 03 endemic and 43 were near endemic. Highest medicinal plants were reported in the altitudinal zone, 2801-3600 and decreased with increasing or decreasing altitude in the study area. These species have been also analyze for their nativity, endemism, rarity and are prioritized for cultivation. An area-specific threat categorization of species is very essential for squat or long term management planning. In present study such an effort in the study area, using information on different attributes was initiated. The presence of critically endangered, endangered and vulnerable medicinal plants indicates high anthropogenic stress on these species. The over-exploitation, habitat degradation and changing environmental conditions may lead to the extinction within a few years. Therefore, regular monitoring of population and habitats, development of conventional protocol, establishment of species in-situ conditions and associated habitats and replication of this approach in other parts of Indian Himalayan Region have been recommended.

**Keywords:** Biodiversity; Ecosystem services; Indigenous uses; Threat categorization; Conservation prioritization; Banjar valley; Himachal Pradesh

## Introduction

The Indian Himalayan Region (IHR) is bestowed with varied natural resources and rich biodiversity. It comprises of five biogeographic provinces, covers approximately an area of 591 thousand km<sup>2</sup> [1] and extending from Jammu & Kashmir in the North-West to the Arunachal Pradesh in the East. IHR one of the mega hot spot of biological diversity [2] is a source of a great diversity of food, fuel, fodder, timber, dye and medicinal plants. It comprises about 18% of India and is more than 2,800 km long and 220 to 300 km wide, with altitudes from 200-8000 m [3]. The IHR alone supports about 8,000 species of angiosperms (40% endemics), 44 species of gymnosperms (15.91% endemics), 600 species of pteridophytes (25% endemics), 1,737 species of bryophytes (32.53% endemics), 1,159 species of lichens (11.22% endemics) and 6,900 species of fungi (27.39% endemics) [4,5]. There are more than 816 tree species and 675 edibles species. 118 species of medicinal plants yields essential oils, 279 species of fodder, 155 sacred plants [6] and 121 rare-endangered plants. Inhabitants of IHR rely on plants for staying healthy and extending the worth of their lives. According to the World Health Organization (WHO) estimates, 3.5 billion populations in the developing countries rely on plant based medicine for primary health care. In Asia, approximately 6500 species of plants are used as household based medicines [7]. However, over 2,500 species are used in India for traditional therapeutic purposes [8]. With the increasing world plea and renewed global interest in increasing preference for natural substances in the health care system, the natural stock of

medicinal plants of the IHR is under terrific pressure [9-12]. The very survival of these resources is now under threat from rapidly expanding human population and concomitant environmental degradation occurring at a fast pace.

A number of studies have been carried out on medicinal plants of the IHR [13]. However, in Himachal Pradesh studies of medicinal plants are scrappy and usually emphasis on inventory, although a few studies have addressed diversity, distribution patterns, nativity, endemism, rarity and conservation prioritization of medicinal plants [14]. Himachal Pradesh has 643 medicinal plants, out of which 269 are native, 374 non-native, 17 endemic, 131 near endemic, 12 critically endangered, 21 endangered, 27 vulnerable, two near threatened and three data deficient [15-18]. The Kullu district of the State is rich in medicinal plant diversity. There is plenty scope for the promotion of medicinal plant cultivation and conservation and as such an integrated

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Received May 06, 2014; Accepted July 15, 2014; Published July 18, 2014

**Citation:** Sharma P, Samant SS, Lal M, Sharma A (2014) Diversity, Indigenous Uses, Threat Categorization and Conservation Prioritization of Medicinal Plants: A Case Study from Himachal Pradesh, India. J Biodivers Endanger Species 2: 134. doi: 10.4172/2332-2543.1000134

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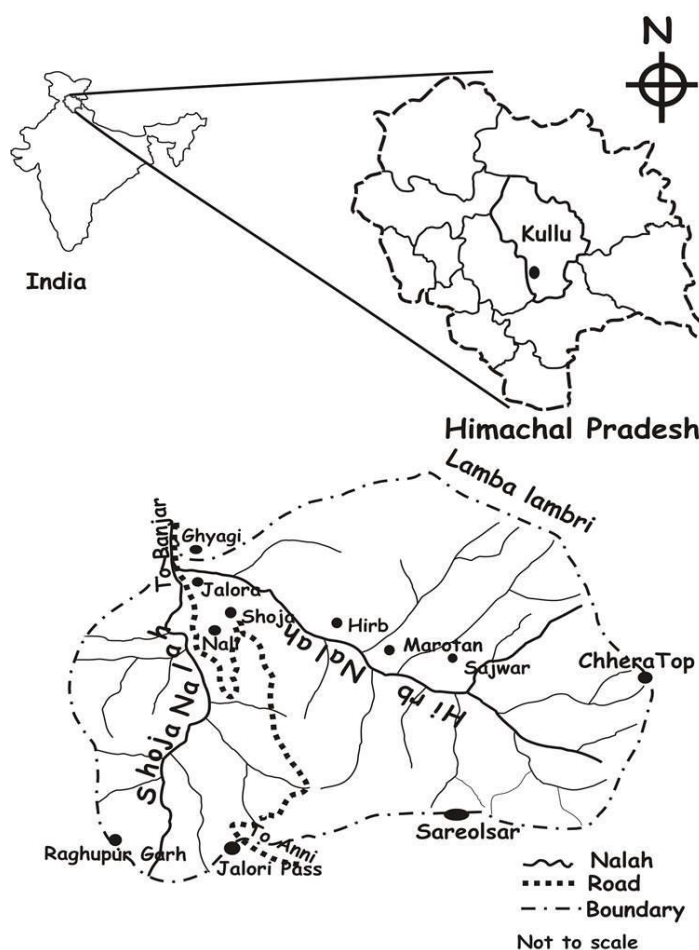
study on diverse parameters of the medicinal plants has not been carried out so far. Therefore, the study conducted in Banjarvalley in Kullu district of the State.

Medicinal plants are worn in the Ayurveda, Unani and other traditional systems of medicine and in plant based pharmaceutical industries. The Tibetan system of medicine is also depends on Himalayan species [19-23]. Estimates indicate that at least 90% of medicinal plant species are extracted from the wild [24-26]; and that 69% of the material is collected through destructive harvesting, which suggests that medicinal plants are significantly threatened. Undue anthropogenic pressures have been identified as the main causes of demur in the population and accessibility of the medicinal plants in the Himalayan region [27]. With the increasing demand and renewed global interest in the healthcare system, the natural stock of medicinal plants of Himachal Pradesh is under tremendous pressure. To provide the information essential to shore up further action, this paper brings together existing information with results from current field surveys.

## Study Area

Banjar valley is a unique ecological landscape situated in the South of Kullu district of Himachal Pradesh which harbours a variety of ecologically diversified landscape elements and supports an array of alpine flowering plants. This area is 50 km from the district

headquarters, Kullu and comes under the Seraj Forest Division. The valley has a large altitudinal range (i.e., 1200-3600 m) (Map). The area is very well known for their diverse habitats, microclimatic conditions and rich biodiversity including flora and fauna. These are mainly dominated by temperate and subalpine broad leaved and coniferous forests, alpine scrubs and alpine herbaceous vegetation, and support a large number of sensitive biodiversity elements including medicinal, wild edible, rare endangered, native, endemic and wild relatives of crop plants. Climatically the area is unique; the temperature ranges between -40°C to 300°C. The Hirb and Shoja streams confluence at Ghyagi and form the Ghyagi stream, which at Jibhi confluences with other stream and form the Jibi Khad a tributary of Tirthan. The Great Himalayan National Park bounds the H&SCs on the eastern side. Eastern side has the highest peak of catchments i.e., Chhera Top at 3600 m. On the western side of the Catchments lies the Garagusheni valley which is a part of Kamrunag Hills of District Mandi. On this side, a famous tourist tracking place, Raghupur Garh is located at the height of 3350 m. Both catchments confluence on the Northern side near Ghyagi. On this side lies the Sainj Valley of Kullu district. On the southern side outer Seraj area of Kullu district bounds the area. The inhabitants depend on the forests for medicinal and wild edible plants, fuel, fodder, timber, making agricultural tools, fiber, religious, livestock grazing and various other purposes. The forests and thatches have been facing high pressure of grazing and over exploitation of the economically important species.



**Map:** Graphical representation of Habit Plant species.

The climate of the area is typically temperate, sub-alpine and alpine types and consists of mainly three distinct seasons-summer season (April-June), rainy season (mid-June-September) and winter season (October-March). However, the autumn (October) and spring (mid-March - mid-April) seasons also prevail in the area. Study area receives precipitation both in the form of snowfall and rainfall. Average annual rainfall was about 1103.2 mm year<sup>-1</sup> in 2007; July and August months receive maximum rainfall [28]. The area witnesses heavy snow fall during December to March. The vegetation mainly comprises of temperate, sub-alpine and alpine types. Temperate and sub-alpine forests are mainly dominated by broad leaved deciduous, evergreen and evergreen coniferous species, and alpine meadows are dominated by alpine scrubs and herbaceous species [29].

## Methods

### Surveys, data collection and analysis

The nine representative villages namely (Banjar, Gayagi, Jalora, Nali, Shoja, Hirb, Sidhwain, Marotan, Sajwar) and surroundings areas of the Banjar valley (1200-3600 m) were surveyed in different seasons, i.e. winter, summer and rainy for five years (2007-2012) to assess the medicinal plant diversity and generate information on utilization of medicinal plants by the inhabitants of the area. Participatory Rural Appraisal (PRA) followed for information generation on medicinal plants. Also, local knowledgeable persons including Vaidhyas were interviewed. Information generated on the indigenous uses and commercial values. Among the knowledgeable persons, one person was hired to collect medicinal plants from the natural habitat(s). The specimens of each species were collected and identified with the help of floras, and research papers [30-33]. Information on locality, altitudinal range, life form, habitat and other morphological characters was collected for each species. The data were compiled and analyzed for diversity and distribution pattern of the species.

### Nativity, endemism, threat categorization and conservation prioritization

The nativity of species represents the primary evidence or origin. Endemism of a species was identified on distribution range of the species [34-36]. Species confined to the IHR were considered as endemic, and those with a distribution extending to neighboring countries (Himalayan region of Afghanistan, Pakistan, Tibet, Nepal, Bhutan and adjacent states of the IHR) were considered as near endemics. The threat categories of the medicinal plants were identified using seven attributes (i.e. habitat preference, distribution range, availability, use value, trade value, extraction and nativity and endemic species) and IUCN criteria. Species with a combination of these criteria (serial number 1, 2 and 3) were given marks accordingly. Species with score >55 were identified as critically endangered; 51-54 as endangered; 46-50 as vulnerable; 40-45 as near threatened; and <40 as least concern (Table 1).

## Results

### Diversity and distribution patterns

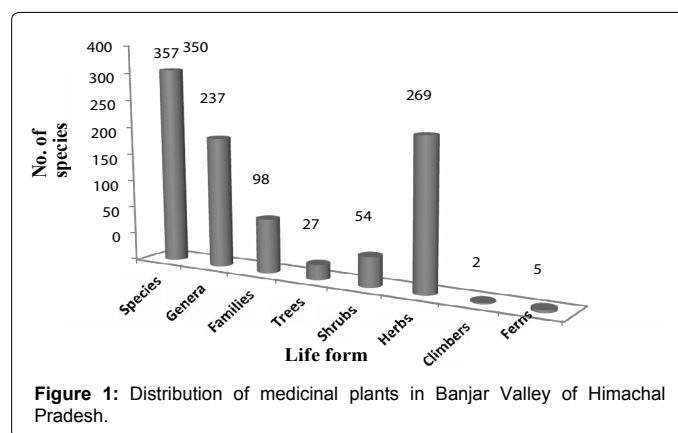
In total, 357 species of medicinal plants belonging to 237 genera

and 98 families were recorded. Of these, 27 species were trees, 54 shrubs, 269 herbs, climbers 02 and ferns 05 each (Figure 1). The families Asteraceae (39 spp.), Lamiaceae, Ranunculaceae and Rosaceae (20 spp. each), Polygonaceae and Apiaceae (15 spp. each), Gentianaceae and Fabaceae (10 spp. each), Scrophulariaceae and Orchidaceae (08 spp. each), Ericaceae and Liliaceae (07 spp. each), Brassicaceae (06 spp.), Berberidaceae, Boraginaceae, Caryophyllaceae, Geraniaceae, Rubiaceae and Poaceae (05 spp. each), Amaranthaceae, Alliaceae, Araceae, Balsaminaceae, Euphorbiaceae, Saxifragaceae, Pinaceae, Plantaginaceae, Oleaceae and Urticaceae (04 spp. each) were rich in medicinal plants. A total of 39 families were monotypic. Among the genera, *Berberis*, *Swertia* and *Nepeta* (5 spp. each), *Anaphalis*, *Anemone*, *Geranium*, *Impatiens*, *Rubus*, *Plantago*, *Rhododendron*, *Polygonum*, *Galium* and *Thalictrum* (4 spp. each), *Allium*, *Arisaema*, *Bupleurum*, *Pleurospermum*, *Chenopodium*, *Euphorbia*, *Hypericum*, *Salvia*, *Polygonatum*, *Oxalis*, *Rheum*, *Rosa*, *Clematis*, *Pedicularis*, *Urtica* and *Viola* (3 spp. each) were dominant and these medicinal plants were recorded from 15 different habitats such as forests, open/alpine slopes, glacial moraines, boulders, cultivated fields, shady moist, shrubberies, riverine, grassland, damp soil/marshy, waste places, dry, epiphytic, rocky and degraded respectively (Appendix).

Maximum richness of medicinal plants (228 spp.: herbs: 192; shrubs: 27; trees: 6; ferns: 2 and climber: 1) were reported in the altitudinal zone, 2801-3600 followed by (95 spp.: herbs: 57; shrubs: 22; trees: 13 and fern: 3) altitudinal zone, 1801-2800 and decreased with decreasing altitude (Figure 2).

### Utilization pattern

Among the parts used of medicinal plants, roots (91 spp.), leaves (128 spp.), flower (29 spp.), seeds (29 spp.), stems (27 spp.), whole plants (87 spp.), wood (09 spp.), bulb (11 spp.), bark (12 spp.), fruits (28 spp.), rhizomes (11 spp.), aerial part (65 spp.), inflorescences (02 spp.), tubers (08 spp.), fronds (03 spp.) were used by the inhabitants of the Banjar valley for their own use or in trade (Figure 3). These parts of the medicinal plants were used in the treatment of different disease categories as gastro-intestinal problems, dermatological problems, respiratory problems, skeletal-muscular pain problems, reproductive/urinary systems problems, blood related problems, hepatic problems,



Serial	Habitat	Distribution	Availability	Use Value >	Trade Value	Extraction	Nativity & Endemism	Score
1	2	<500	Low	10	High	Commercial	Native & Endemic	10
2	3-4	500-1000	Moderate	5-10	Medium	Self-use	Native/ Endemic	6
3	5	>1000	High	<5	Low	No use	Non-native	2

**Table 1:** Criteria used for prioritization of medicinal plants for conservation in Banjar Valley of Himachal Pradesh.

ENT problems, anti-poisonous, oral/dental problems, nervous related problems and some miscellaneous problems. Maximum species were used for fever (65 spp.), followed by stomach problems (58 spp.), cough (52 spp.), gastric complaints (45 spp.), skin problems (43 spp.) and rheumatism (33 spp.) (Table 3). From these medicinal plants, roots of *Angelica glauca* were used in dysentery, gastric complaints, menorrhea, stomach disorder, vomiting and bronchitis; *Aconitum heterophyllum* were used in cold, cough, diarrhoea, fever, gall bladder, abdominal pain, gastric, piles; *Picrorhiza kurroo* in anaemia, arthritis, asthma, cold, diarrhoea, diuretic, fever, jaundice, liver trouble, stomach; *Podophyllum hexandrum* in cancer, cough, constipation, tuberculosis, gynecological disorder, skin diseases, tumors, cuts, wounds, diarrhoea, gastric ulcer; *Rheum australe* in abdominal pain, appetite, asthma, bronchitis, fever, cuts, dysentery, eye disorder, sprain, swelling, ulcer, wounds; tubers of *Dactylorhiza hatagirea* used as anti-biotic, wound healing, bone fracture, cough, cold, cuts, sexual disability, rheumatism, blood purifier, tonic, expectorant; bark of *Taxus baccata* subsp.

*wallichiana* used as anti-cancerous, blood purifier, swelling, fever, asthma, contraceptive, etc. (Appendix).

## Nativity and Endemism

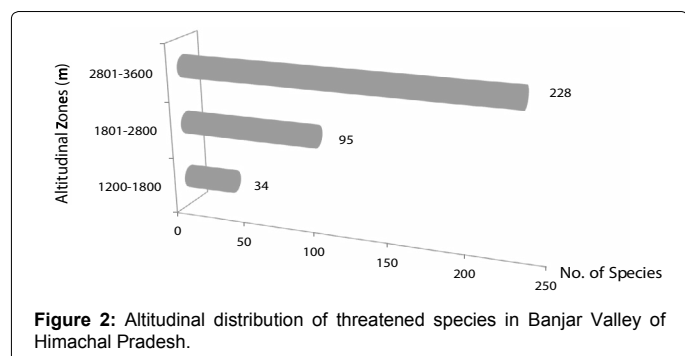
Of the total species recorded, 193 species were native to the Himalayan region, while 164 species were non-native, from different domains of the world. 3 species were endemic restricted to the IHR (*Angelica glauca*, *Elsholtzia flava* and *Wikstroemia canescens*) and 43 species were identified as near-endemics (Appendix). The number of native, endemic and near-endemic species appears to increase along an altitudinal gradient irrespective of the total species richness.

## Threat Categorization and Conservation Prioritization

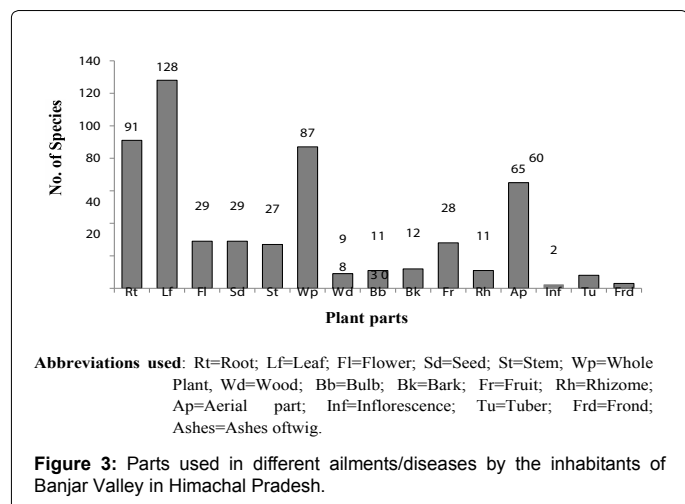
12 species were identified as critically endangered, 13 as endangered, 20 as vulnerable, 14 species as near threatened and 298 as of least concern (Table 2). The species identified as critically endangered, endangered and vulnerable have been prioritized for conservation. Among these 45 prioritized medicinal plants 28 species were highly scored and possess high prioritization score, based on their demand and market potential (Figure 4). The healing plants prioritized for conservation were critically endangered, endangered and vulnerable categories species as *Corydalis govaniana*, *Trillium govanianum*, *Rhododendron campanulatum*, *Plantago himalaica*, *Valeriana hardwickii*, *Angelica glauca*, *Saussurea albescentis*, *Pistacia integerrima*, *Podophyllum hexandrum*, *Rheum australe*, *Meconopsis aculeata*, *Taxus baccata* subsp. *wallichiana*, *Allium wallichii*, *Acorus calamus*, *Gentiana kurroo*, *Inula grandiflora*, *Dactylorhiza hatagirea*, *Paeonia emodi*, *Zanthoxylum armatum*, *A. violaceum*, *Betula utilis*, *Lilium polyphyllum*, *Jurinella macrocephala*, *Paris polyphylla*, *Skimmia laureola*, *Aconitum heterophyllum*, *Picrorhiza kurroo* were recommended for commercial cultivation in the Banjar Valley (Table 2).

## Discussion

The IHR is well known for its diversity of Medicinal plants [4,5,8]. However, studies on medicinal plants at catchment, watershed and valley specific are not available. Therefore, the present study provides comprehensive baseline catalogue on diversity, distribution pattern, nativity, endemism, rarity, utilization patterns, indigenous uses and part/s used of medicinal plants in Banjar valley of Himachal Pradesh, North western Himalaya. The occurrence of 357 species of medicinal plants in the area indicates that its environmental conditions, particularly, shady moist and forest habitats, are suitable for growth and development of such species. The habitats require regular monitoring to categorize the dynamics of the flora. The altitudinal range 2801-3600 m has the most vegetation of medicinal plants. The occurrence of 54.1% of native species, 12.1% of near endemic species and 0.8% of endemic species shows the high significance of the area. Habitat degradation and over exploitation of these species may lead to their early extinction in the area. The over exploitation of medicinal plants parts such as roots,



**Figure 2:** Altitudinal distribution of threatened species in Banjar Valley of Himachal Pradesh.



**Abbreviations used:** Rt=Root; Lf=Leaf; Fl=Flower; Sd=Seed; St=Stem; Wp=Whole Plant; Wd=Wood; Bb=Bulb; Bk=Bark; Fr=Fruit; Rh=Rhizome; Ap=Aerial part; Inf=Inflorescence; Tu=Tuber; Frd=Frond; Ashes=Ashes of twigs.

**Figure 3:** Parts used in different ailments/diseases by the inhabitants of Banjar Valley in Himachal Pradesh.

	Critically Endangered	Endangered	Vulnerable	Near Threatened
Banjar Valley	<i>Aconitum heterophyllum</i> , <i>A. violaceum</i> , <i>Allium wallichii</i> , <i>Betula utilis</i> , <i>Dactylorhiza hatagirea</i> , <i>Jurinella macrocephala</i> , <i>Lilium polyphyllum</i> , <i>Paris polyphylla</i> , <i>Paeonia emodi</i> , <i>Picrorhiza kurroo</i> , <i>Skimmia laureola</i> , <i>Zanthoxylum armatum</i> ,	<i>Acorus calamus</i> , <i>Angelica glauca</i> , <i>Allium humile</i> , <i>Bergenia stracheyi</i> , <i>Corydalis govaniana</i> , <i>Gentiana kurroo</i> , <i>Saussurea albescentis</i> , <i>Pistacia integerrima</i> , <i>Podophyllum hexandrum</i> , <i>Rheum webbianum</i> , <i>Rhododendron campanulatum</i> , <i>Taxus baccata</i> subsp. <i>wallichiana</i> , <i>Delphinium denudatum</i>	<i>Rheum australe</i> , <i>Heracleum candicans</i> , <i>Arctium lappa</i> , <i>Saussurea heteromalla</i> , <i>Berberis asiatica</i> , <i>B. chitria</i> , <i>B. jaeschkeana</i> , <i>Rhododendron anthopogon</i> , <i>Corydalis comuta</i> , <i>Swertia cordata</i> , <i>Polygonatum multiflorum</i> , <i>P. cirrhifolium</i> , <i>Plantago himalaica</i> , <i>Primula rosea</i> , <i>Bergenia ligulata</i> , <i>Viola pilosa</i> , <i>Valeriana jatamansi</i> , <i>V. hardwickii</i> , <i>Hedychium spicatum</i> , <i>Rosa sericea</i>	<i>Hypericum perforatum</i> , <i>H. oblongifolium</i> , <i>Allium victorialis</i> , <i>Bupleurum lanceolatum</i> , <i>Selinum tenuifolium</i> , <i>Berberis lyceum</i> , <i>Viburnum cotinifolium</i> , <i>Cassiope fastigiata</i> , <i>Hypericum uralum</i> , <i>Juglans regia</i> , <i>Nepeta discolor</i> , <i>N. longibracteata</i> , <i>Thymus linearis</i> , <i>Viscum album</i>

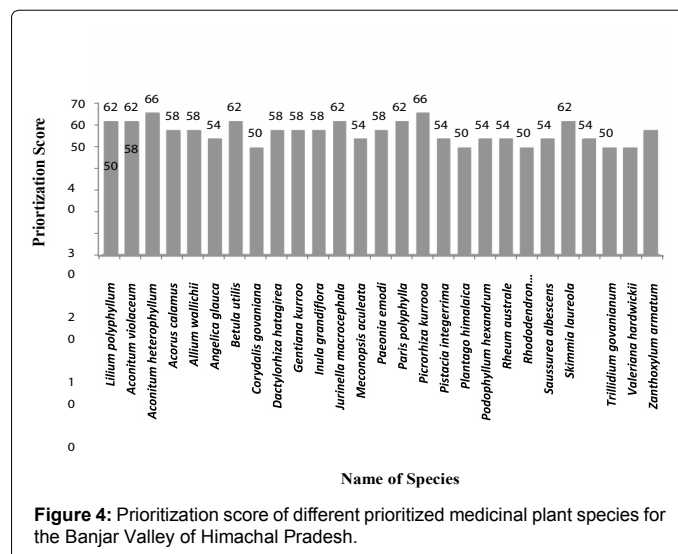
**Table 2:** Threat Categorization of medicinal plants in Banjar Valley of Himachal Pradesh.



rhizomes, tubers, inflorescences, fruits, oils, bark, seeds, etc. may lead to poor regeneration and extinction of these species in near future.

Ailments/Diseases	No. of Species	Ailments/Diseases	No. of Species
Abcesses	4	Ear and eye complaints	22
Abdominal disease	8	Eczema	9
Abortifacient	2	Epilepsy	5
Acidity	2	Febrifuge	11
Anaemia	3	Fever	65
Analgesic	4	Gastric complaints	45
Anti-helminthic	17	Gonorrhoea	7
Anti-bacterial	5	Haemorrhoids	17
Anti-biotic	4	Headache	24
Anti-cancerous	4	Heart disease	2
Anti-fertility	8	Hepatic	6
Anti-fungal	7	Hysteria	6
Anti-inflammatory	2	Inflammation	3
Anti-septic	13	Insecticidal	7
Anti-spasmodic	6	Intestinal complaints	2
Aphrodisiac	9	Itching	4
Appetizer	14	Jaundice	16
Arthritis	2	Kidney	10
Asthma	16	Laxative	13
Astringent	15	Leprosy	6
Backache	4	Leucoderma	6
Blood pressure	2	Leucorrhoea	2
Blood purifier	22	Liver	14
Bodyache	8	Liver complaints	7
Boils	20	Malaria	11
Bone fracture	12	Menorrhoea	8
Bronchitis	24	Menstrual complaints	7
Burns	9	Nervous disorder	10
Carminative	6	Pain	20
Chest pain	2	Pimples	6
Cholera	4	Pneumonia	4
Cold	34	Poultice	7
Colic	13	Purgative	10
Constipation	5	Renal disorder	7
Contraceptive	3	Rheumatism	33
Cough	52	Ring worm infection	8
Cuts	32	Rodents killing	8
Diabetes	2	Scorpion/Snake bite	25
Diaphoretic	6	Skin ailments	43
Diarrhoea	36	Veterinary diseases	9
Diuretic	24	Sores	12
Dysentery	32	Stimulant	7
Dyspepsia	7	Stomach disorders	58
Swelling	10	Toothache	14
As tonic	34	Ulcer	14
Urinary complaints	19	Wounds	54

**Table 3:** Utilization pattern of medicinal plant species in different ailments/diseases in Banjar Valley of Himachal Pradesh.



**Figure 4:** Prioritization score of different prioritized medicinal plant species for the Banjar Valley of Himachal Pradesh.

An area specific threat categorization of species is most important for short or long term management planning. The present study represents such an approach in this area, using information on different attributes. Cultivation of such medicinal plants in the surrounding villages and other private lands may condense the extinction pressure on the wild habitats. Identification of active ingredients would help identifying the potential species for marketing. Regular populations and habitats monitoring of native, endemic and threatened medicinal plants using ecological methods and notification of key areas as medicinal plants conservation areas (MPCAs) for in situ conservation, with the involvement of the State Forest Department and inhabitants of the area have been suggested. Besides these, mass reproduction using conventional methods, establishment and maintenance of herbal gardens and medicinal plant nurseries for ex situ conservation and ensuring the availability of quality planting material for cultivation, together with education and awareness programmes for large scale cultivation area recommended.

#### Acknowledgement

The authors are greatly thankful to the Director, G.B. Pant Institute of Himalayan Environment & Development, Kosi-Katarmal, Almora, Uttarakhand, India for the facilities and encouragement. Authors are thankful to the inhabitants of the area for providing valuable information during the field surveys.

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