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Ethno-Botanical Diversity and Conservation Status of Medicinal Flora at High Terrains of Garhwal (Uttarakhand) Himalaya, India: A Case Study in Context to Multifarious Tourism Growth and Peri-Urban Encroachments

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Abstractt—The high terrains of Garhwal (Uttarakhand) Himalaya are the niches of a number of rare and endemic plant species of great therapeutic importance. However, the wild flora of the area is still under a constant threat due to rapid upsurge in human interferences, especially through multifarious tourism growth and peri-urban encroachments. After getting the status of a 'Special State' of the country since its inception in the year 2000, this newly borne State led to very rapid infrastructural growth and development. Consequently, its townships started expanding in an unmanaged way grabbing nearby agricultural lands and forest areas into peri-urban landscapes. Simultaneously, a boom in tourism and pilgrimage in the state and the infrastructural facilities raised by the government for tourists/pilgrims are destroying its biodiversity. Field survey revealed 242 plant species of therapeutic significance naturally growing in the area and being utilized by local inhabitants as traditional medicines. On conservation scale, 6 species (2.2%) were identified as critically endangered, 19 species (7.1%) as the endangered ones, 8 species (3.0%) under rare category, 17 species (6.4%) as threatened and 14 species (5.2%) as vulnerable. The Government of India has brought mega-biodiversity hot spots of the state under Biosphere Reserve, National Parks, etc. restricting all kinds of human interferences; however, the two most sacred shrines of Hindus and Sikhs viz. Shri Badrinath and Shri Hemkunt Sahib, and two great touristic attractions *viz.* Valley of Flowers and Auli-Joshimath Skiing Track oblige the government to maintain equilibrium between entries of visitors *vis-à-vis* biodiversity conservation in high terrains of Uttarakhand Himalaya.

Keywords—Biodiversity conservation, ethno-botany, Garhwal (Uttarakhand) Himalaya, peri-urban encroachment, pilgrimage and tourism.

I. Introduction

UTTARAKHAND Himalayas, blessed with magnificent mountains, pristine forests, and openings of the 18 rivers of India, is a center of mega-biodiversity, international tourist spots, and one of the most sacred pilgrimage place of Hindus and Sikhs. Since ages, Hindu belief holds that having a journey to this place absolves human being of all sins and helps him/her to attain salvation. Millions of tourists and pilgrims pay homage to its spirituality and scenic beauty every year. Shri Badrinath, Kedarnath, Rudranath, Tungnath, Kalpeshwar, Madhyamaheshwar, Adi Badri, Bhavishya Badri, Kali Math, Joshimath, Hemkund Sahib, etc. are the most prominent pilgrimage sites of Hindus and Sikhs, whereas the great peaks of Panpati Glacier (5553 m), Chaukhambha (a cluster of 4 peaks; measuring 6974 m to 7138 m), Kanaldani Khal (5968 m), Mukut Parvat (7242 m), cluster of Unta Dhura- GonkhaGad- Finga- Bampa Dhura (6355 m, 5749 m, 5096 m, 6241 m, 4600 m), Mapang- Nandakot (6861 m), Bajeiling Dhar (5816-5645 m) Baratola (5553 m), etc. infatuate thousands and thousands of trekkers and mountaineers every year. Jim Corbett National Park, Valley of Flowers National Park, Nanda Devi National Park, Rajaji National Park, Govind PashuVihar National Park and Gangotri National Park are the centers of ethno-botanical diversity and niches of a number of medicinal species, but at the same time are the prime sites of attraction for visitors coming to Uttrakhand [1]-[6].

The tourism linked trade and hospitality accounts for 30% of the state economy making Uttarakhand one of the fastest growing economies of the country. In spite of having 85% land area under forest cover followed by poor industrial and agricultural support, the per capita income in Uttarakhand was Rs 82,193.00 in the year 2011-12, Rs 92,191.00 in the year 2012-13, and Rs 103,000.00 in the year 2013-14, which was significantly higher than the national average of Rs 60,603.00, Rs 82,401.00 and Rs 93,249.00, respectively, in the corresponding years [7]. This growth is largely associated with boom in pilgrimage and tourism resulting into gross state domestic production (GSDP) of Uttarakhand from Rs 2478.6 million in the year 2005 to Rs 6089.8 million in 2012 and grew at the rate of 15.32% during financial year 2004-05 to 2014-15 [8]. According to Uttarakhand Tourism Development Master Plan 2020 prepared by the Tourism Department of the state, it has been estimated that the number of national and international visitors would reach up to 78.22 million in the year 2017-18, almost seven times higher than the state population of 10.12 million. This exponential rise in pilgrimage and tourism is demanding massive increase of infrastructural facilities resulting into fast peri-urban encroachments with a collateral threat to biodiversity of the

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area [9]–[13]. Intruders/herb-smugglers are also entering in the area and are illegally collecting tons of valuable medicinal and aromatic species every year including the endangered ones causing ruthless exploitation of the precious vegetal wealth of Uttarakhand Himalaya [14]-[17]. Consequently, to stop the exploitation of the herbal wealth, the Government of India has declared mega-biodiversity spots of Uttarakhand into National Parks, Sanctuaries and Biosphere Reserve restricting all kinds of human interferences in the region [18], [19]; however, it is a riddle for the government to restrict entries of pilgrims and tourists in megadiversity areas of Uttarakhand Himalaya [20], [21].

II. Methodology

Data related to ethnobotanical diversity of all the angiospermic and gymnospermic flora in general and that of medicinal species in particular, were collected, identified and categorized as detailed elsewhere [22], [23]. Information related to tourism and pilgrimage was collected partly by the author's team and partly from official documents/reports of the Uttarakhand government. Likewise, information on peri-urban encroachments following infrastructural expansion associated with tourism and pilgrimage was gathered from the publications of the revenue and forest departments of the state government as well as from the environmentalists, geologists, etc. working in the area and media reports apart from the observations and reports gathered by the author's team. Roll and effect of peri-urban encroachments, tourism pressure, and unethical human activities over biodiversity was studied and analyzed in context to ethnobotanical details and traditional utilization of the collected species by local inhabitants, especially the tribals as detailed in various reports and review articles [22]-[24]. Endemic, exotic, indigenous and/or endangered/rare plant species were categorized as per International norms. Conservation status of the specific medicinal and aromatic species growing in the area was determined following IUCN criteria accompanied with recording of magnitude and methods of their commercial/ traditional harvests/exploitation [25].

III. Observations & Analyses

Ethnobotanical observations revealed a total of 267 angiospermic and gymnospermic species growing in the area, out of which 178 species (Table I) were recognized as the 'magic herbs' being utilized by local inhabitants as their community medicine to cure ailments of the human beings, especially by head-men of the tribals residing in deep dense forests of Uttarakhand Himalaya and 22 plant species (Table II) were being utilized as the supplements with other medicinal species mentioned in Table I to enhance potency of the latter in use and/or to reduce their side-effects. The remaining plant species were recorded as species providing food, fodder, shelter and/or being utilized as veterinary medicines.

TABLE I
Species Utilized as Traditional Medicines

S.No.	Botanical Names	Therapeutic uses
1.	*Abies pindrow*	Masculine power
2.	*Abina bcordifolia*	Wound healing
3.	*Abrus precatorius*	Fever, asthma, chest pain, tuberculosis
4.	*Abutilon indicum*	Diabetes
5.	*Acacia catechu*	Urinary trouble, dysentery
6.	*Allium wallichii*	Stomach problem, infection
7.	*Acacia nilotica*	Dental care
8.	*Achillea millefolium*	Indigestion, appetizer
9.	*Achyranthes bidentata*	Wounds, snake bite
10.	*Achyranthes aspera*	Muscular cramps, toothache
11.	*Aconitum balfourii*	Antipyretic, antiseptic, would healing
12.	*Aconitum heterophyllum*	Stomach pain, fever, cough & cold, diarrhea
13.	*Aconitum atrox*	Rheumatism, neuralgia, paralysis, fever
14.	*Acorus calamus*	Weakness
15.	*Adhatoda vasica*	Whooping cough, skin diseases, headache, dysentery
16.	*Adhatoda zeylanica*	Fever, cough & cold, energizer
17.	*Aegle marmelos*	Diarrhea
18.	*Aesculus indica*	Stomach problem
19.	*Ajuga brachystemon*	Malaria
20.	*Ajuga bracteosa*	Malaria
21.	*Ajuga parviflora*	Arthritis
22.	*Aleo barbadensis*	Liver problem, diabetes
23.	*Allium sativum*	Appetizer
24.	*Anagallis arvensis*	Pain killer
25.	*Andrographis paniculata*	Liver tonic
26.	*Anemone obtusiloba*	Diarrhea
27.	*Anemone vitifolia*	Ringworm, eczema
28.	*Anemone polyanthes*	Food poisoning
29.	*Anethum sowa*	Health tonic
30.	*Angelica glauca*	Flatulence, colic pain, appetizer
31.	*Angelica archangelica*	Flatulence, colic pain, appetizer
32.	*Argemonemexicana*	Leprosy
33.	*Arisaema acquemontii*	Snake bite antidote
34.	*Arisaema propinquum*	Erysipelas, scabies
35.	*Arisaema tortuosum*	Snake bite
36.	*Arnebia benthamii*	Cuts & burns
37.	*Arnebia euchroma*	Cuts & burns
38.	*Artemisia maritime*	Indigestion
39.	*Artemisia nilagirica*	Malarial fever, wound healing, headache, stomach pain
40.	*Artemisia sacrorum*	Baldness
41.	*Asparagus adscendens*	Sexual disability, urino-genital disorders
42.	*Astragalus candolleanus*	Blood and skin diseases, tuberculosis
43.	*Azadirachta indica*	Antiseptic
44.	*Bacopa monnieri*	Brain sharpener
45.	*Bauhinia variegate*	Health tonic
46.	*Berberis lyceum*	Diabetes, skin disease
47.	*Berberis aristata*	Jaundice, fever, weakness
48.	*Berberis asiatica*	Antipyretic
49.	*Berberis chitria*	Jaundice, eye trouble
50.	*Bergenia ciliata*	Kidney stone, sores, swelling
51.	*Bergenia ligulata*	Antipyretic
52.	*Boerhaavia diffusa*	Jaundice, asthma, bronchitis, eye problems
53.	*Bombax malabaricum*	Menstrual problem
54.	*Butea parviflora*	Hair loss

S.No.	Botanical Names	Therapeutic uses
55.	*Callicarpa macrophylla*	Rheumatic pain
56.	*Calotropis procera*	Indigestion, cold & cough, asthma
57.	*Cassia absus*	Eye problem
58.	*Cassia occidentalis*	Skin disease, cuts, wounds, bone fracture, liver problem
59.	*Cassia fistula*	Stomach disorder
60.	*Cassia tora*	Skin disease, piles, snake bite, dropsy
61.	*Cureuma angustifolia*	Antiseptic, stomach problem
62.	*Celastrus paniculatus*	Impotency
63.	*Centella asiatica*	Mental disorder
64.	*Cinnamomum tamala*	Gastric trouble, cough & cold
65.	*Cinnamomum zeylanicum*	Anti-wormis
66.	*Cissampelos pareira*	Impotency
67.	*Coriandrum sativum*	Liver problem
68.	*Cuminum cyminum*	Indigestion
69.	*Cuscuta europaea*	Skin disease
70.	*Datura stramonium*	Asthma
71.	*Delphinium elatum*	Conjunctivitis
72.	*Digitalis purpurea*	Burn & boils
73.	*Dioscorea deltoidea*	Urino-genital disorders
74.	*Dioscorea bulbifera*	Bronchial cough, antiseptic, burn wounds
75.	*Eclipta prostrate*	Gastric trouble
76.	*Embelia ribes*	Dental problem, appetizer
77.	*Emblica officinalis*	Stomach problem
78.	*Ephedra gerardiana*	Pain killer
79.	*Eucalyptus globules*	Headache
80.	*Eugenia jambolana*	Diabetes
81.	*Euphorbia hirta*	Piles, wart, bronchial infection, asthma
82.	*Evolvulus alsinoides*	Cough, cold, asthma, bronchitis
83.	*Ficus benghalensis*	Stomach disorder
84.	*Foeniculum vulgare*	During pregnancy
85.	*Fragaria vesca*	During pregnancy
86.	*Gaultheria fragrantissima*	Burn & boils, pain killer
87.	*Gentiana tenella*	Mental and physical weakness
88.	*Gloriosa superba*	Painful delivery, suppressed urination
89.	*Hedychium spicatum*	Asthma, tuberculosis, piles
90.	*Hemidesmum indicus*	Menstrual disorder
91.	*Heracleum candicans*	Leukoderma
92.	*Hibiscus rosa-sinensis*	Laxative
93.	*Holarrhena antidysenterica*	Dysentery, gastric trouble
94.	*Hyoscyamus niger*	Pain killer, muscle strength
95.	*Juglans regia*	Gastric trouble
96.	*Lawsonia alba*	Skull-skin infection
97.	*Leucas cephalotes*	Diaphoretic¸ snakebite
98.	*Linum usitatissimum*	Waist pain, weakness
99.	*Litsea glutinosa*	Bone fracture
100.	*Lobelia pyramidalis*	Indigestion, stomach problem
101.	*Mallotus philippensis*	Anti-wormis
102.	*Melilotus alba*	Indigestion, diabetes
103.	*Mentha arvensis*	Stomach pain
104.	*Mentha spiata*	Stomach pain
105.	*Mimosa pudica*	Piles
106.	*Myrica esculenta*	Headache
107.	*Nardostachys jatamansi*	Epilepsy, hysteria, jaundice
108.	*Ocimum sanctum*	Cough & cold
109.	*Onosma bracteatum*	Skull-skin problems
110.	*Operculina turpethum*	Health tonic
111.	*Origanum vulgare*	Bronchitis, whooping cough, diarrhea, colic pain, menstrual cycle
112.	*Oroxylum indicum*	Joint pain
113.	*Picrorhiza kurrooa*	Antipyretic
114.	*Piper longum*	Appetizer
115.	*Plantago lanceolata*	Cuts, wounds, piles, stomach ailments
116.	*Plantago depressa*	Cuts, wounds, piles, stomach ailments
117.	*Plantago major*	Tooth problems
118.	*Plantago orata*	Gastric problems
119.	*Polygonatum tortuosum*	Menstrual cycle
120.	*Polygonatum verticillatum*	Joint pain
121.	*Potentilla argyrophylla*	Stomach problem
122.	*Potentilla fulgans*	Gastric trouble
123.	*Prinsepia utilis*	Rheumatic pain, diarrhea
124.	*Prunus cerasoides*	Psycho-medicine, body swelling
125.	*Pterocarpus marsupium*	Diabetes
126.	*Punica granatum*	Weakness
127.	*Quercus semecarpifolia*	Gastric problems
128.	*Quercus dilatata*	Gastric problems
129.	*Rauvolfia serpentina*	Fever, anxiety, epilepsy, intestinal & nervous disorders
130.	*Rhamnus virgata*	Muscular problem
131.	*Rheum austral*	Liver problem
132.	*Rheum webbianum*	Astringent
133.	*Rheum emodi*	Bone & muscular pain
134.	*Ricinus communis*	Wound healing, injury, muscular pain
135.	*Rosa moschata*	Leucorrhoea
136.	*Rubus lasiocarpus*	Health tonic during pregnancy
137.	*Rubus paniculatus*	Health tonic during pregnancy
138.	*Rumex hastatus*	Cuts, wounds, bleeding, fever
139.	*Salvia lanata*	Gastric problems
140.	*Sarca asoca*	Menstrual disorder
141.	*Saussurea obvallata*	Antiseptic, cuts & burns, cough & cold
142.	*Senecio rufinervis*	Wound healing
143.	*Senecio chrysanthemoides*	Skin problems
144.	*Smilax aspera*	Diuretic, diaphoretic, rheumatic arthritis
145.	*Solanum anguivi*	Masculine power
146.	*Solanum nigrum*	Spleen, diarrhea, eye ailments, piles
147.	*Sphaeranthus indicus*	Diabetes
148.	*Spondia spinnata*	Stomach and ear problems
149.	*Strychnos nux-vomica*	Masculine power
150.	*Swertia chirayita*	Diabetes
151.	*Swertia angustifolia*	Blood disease, malaria, health tonic
152.	*Swertia chirayita*	Health tonic, fever, appetizer, leukoderma
153.	*Symplocos racemosa*	Health tonic
154.	*Syzygium cumini*	Diabetes
155.	*Tanacetum nubigenum*	Antiseptic
156.	*Taxus baccata*	Anti-cancerous
157.	*Taxus wallichiana*	Anti-cancerous
158.	*Tecom ellundulate*	Liver tonic
159.	*Terminalia chebula*	Stomach problem
160.	*Terminalia arjuna*	Heart ailments, mental & menstrual problems
161.	*Terminalia bellirica*	Stomach problem
162.	*Thalictrum foliolosum*	Eye inflammation
163.	*Thymus serpyllum*	Muscular pain
164.	*Tinospora sinensis*	Leprosy, urinary trouble, malaria
165.	*Tinspora cardifolia*	Liver, heart & mental problems

S.No.	Botanical Names	Therapeutic uses
166.	*Trigonella foenumgraecum*	Diabetes, hair loss, appetizer
167.	*Urtica dioica*	Sciatica, rheumatism, skin disease
168.	*Valeriana jatamansi*	Aphrodisiac, mental disorders
169.	*Viola betonicifolia*	Sinusitis, skin & blood diseases, diaphoretic, fever, cough
170.	*Viola pilosa*	Cough & cold
171.	*Viola patrinii*	Liver problem
172.	*Viola odorata*	Antipyretic
173.	*Vitex nigundo*	Rheumatism, arthritis
174.	*Withania somnifera*	Urinary disorders, fever, insomnia
175.	*Woodfordia fruticosa*	Hemorrhoids febrifuge, menstrual disorder
176.	*Woodfordia floribunda*	Energy tonic
177.	*Zanthoxylum armatum*	Toothache, tooth decay
178.	*Zingiber officinale*	Cough & cold

TABLE II
SPECIES UTILIZED AS SUPPLEMENTS WITH OTHER MEDICINAL PLANTS

S. No.	Botanical Name	Plant Part Utilized
1.	*Acorus calamus*	Rhizome & leaf
2.	*Amaranthus polygamus*	Leaf
3.	*Asparagus racemosus*	Root
4.	*Azadirachta indica*	Leaf
5.	*Boswellia serrata*	Bark & gum
6.	*Cassia fistula*	Fruit & root
7.	*Cissampelos pareira*	Root
8.	*Glycyrrhiza glabra*	Stem & root
9.	*Gmelina arborea*	Bark & root
10.	*Hygrophila auriculata*	Root, leaf and seed
11.	*Hygrophila spinosa*	Leaf, seed and root
12.	*Nerium odorum*	Leaf & root
13.	*Pinnus roxburghii*	Bark
14.	*Pistacia khinjuk*	Leaf
15.	*Plumbago zeylanica*	Root
16.	*Rubia cordifolia*	Root
17.	*Shorea robusta*	Leaf & bark
18.	*Shorea robusta*	Leaf & bark
19.	*Sida cordifolia*	Leaf & root
20.	*Solanum surattense*	Leaf
21.	*Spinacia oleracea*	Leaf & fruit
22.	*Vernonia cinerea*	Leaf, flower & seed

Plant species being utilized as food and/or fodder are *Abies webbiana, Aconitum violaceum, Agrimon apilosa, Alternanther sessilis, Argyrcia nervosa, Artemisia parviflora, Bergenia stracheyi, Betulautilis, Butea monosperma, Capsella bursapastoris, Capsicum annum, Cardamine impatiens, Cedrus deodara, Chenopodium album, Clerodendrum infortunatum, Cyperus rotundus, Dactylorhiza hatagirea, Datura metal, Daucus carota, Didymocarpus pedicellata, Elettaria cardamomum, Euphorbia prolifera, Ficus caraca, Fritillaria roylei, Fumaria indica, Gentiana pretense, Gentiana kurroo, Hippophae rhamnoides, Hypericum cernum, Hyssopus officinalis, Juniperus communis, Jurinea dolomiaea, Leptadenia reticulata, Litsaea polyantha, Litsaea umbrosa, Malaxis muscifera, Mangifera indicia, Meconopsis aculeata, Melia azedarach, Moringa pterygosperma, Nelumbo nucifera, Orchis latifolia, Phyllanthus fraternus, Physochlaina praialta, Pimpinella diversifolia, Podophyllum hexandrum, Polygonatum multiflorum, Pongamia pinnata, Primula denticulate, Primula macrophylla, Pueraria tuberosa, Rheum moorcroftianum, Rheum spiciforme, Rhododendron anthopogon, Rhododendron campanulatum, Rhododendron lepidotum, Ribes grossularia, Salix elegans, Sapindus mukorossi, Saussurea costus, Saussurea gossypiphora, Scutellaria angulosa, Swertia purpurascens, Tagetes minuta, Tephrosia purpurea, Tribulus terrestris, Trifolium repens, Verbascum thapsus, Viola serpens, Viola biflora, Viscum album* and *Vitis vinifera*.

Plant species facing ruthless exploitation by various means including all shorts of human interferences and requiring immediate attention were categorized Following IUCN criterion of conservation (Table III).

TABLE III
CATEGORIZATION OF PLANT SPECIES ON CONSERVATION CRITERION

Category	Name of Plant Species
Critically endangered species	*Arnebia benthamii, Dactylorhiza hatagirea, Fritillaria roylei, Saussurea costus, Swertia chirayita, Taxus wallichiana*
Endangered species	*Aconitum heterophyllum, Angelica glauca, Arnebia euchroma,Artemisia maritima, Bergenia ciliate, Betula utilis, Ephedra gerardiana, Gentia nakurroo, Gloriosa superba, Jurinea dolomiaea, Meconopsis aculeate, Nardostachys jatamansi, Picrorhiza kurrooa, Plantago depressa, Podophyllum hexandrum, Rauvolfia serpentine, Rheum webbianum, Saussurea gossypiphora, Swertia angustifolia*
Rarely Distributed species	*Ajuga brachystemon, Anemone obtusiloba, Anemone polyanthes, Astragalus candolleanus, Berberis lyceum, Boerhaavia diffusa, Hedychium spicatum, Leucas cephalotes*
Threatened species	*Abrus precatorius, Aconitum atrox, Arisaema jacquemontii, Arisaema tortuosum, Asparagus adscendens, Berberis chitria , Dioscorea deltoidea, Hippophae rhamnoides, Hyoscyamus niger, Litsea glutinosa, Prunus cerasoides, Thalictrum foliolosum, Tinospora sinensis, Withania somnifera, Zanthoxylum armatum, Callicarpa macrophylla, Calotropis proceraas*
Vulnerable species	*Aconitum violaceum, Bergenia stracheyi, Malaxis muscifera, Physochlaina praialta, Polygonatum multiflorum, Polygonatum verticillatum, Rheum australe, Rheum emodi, Rheum moorcroftianum, Rheum spiciforme, Rhododendron anthopogon, Rhododendron campanulatum, Rhododendron lepidotum, Saussurea obvallata*

Trekkers, tourists, and pilgrims often pluck flowers, fruits, seeds, barks and/or the whole plant of specific species viz. *Saussurea obvallata* (Brahmakamal- a mythical flower of Gods), *Aconitum heterophyllum, Arnebia benthamii, Betul autilis, Corydalis* spp., *Dactylorhiza hatagirea, Orchis habenarioides, Picrorhiza kurrooa, Rhem* spp., *Taxus wallichiana, Angelica glauca, Carum carvii, Hyssopus officinalis, Juniperus* spp., *Jurinea dolomiaea, Nardostachys grandiflora, Origanum vulgare, Pleurospermum brunois, Saussurea costus, Thymus linearia, Valeriana hardwickii*, etc. as a 'remembrance' of their journey and as a gift of God. Some of them pluck any of the species again and again blooming along their ways just for fun, play with them for a few minutes and then through them ruthlessly. However, the actual threat to the species having medicinal, aromatic, and/or any other commercial/economic value and growing in remote

areas of high altitude Uttarakhand Himalayas come from smugglers intruding in the area disguised as tourists and collecting tons of precious herbs endangering the sustainability of specific species. Species of *Taxus, Bergina, Astragalus, Allium, Primula, Cupressus, Pleurospermum, Juniperus, Artemisia, Nardostachif, Jurinea, Acoitum, Batula, Crocos, Dactylorhiza, Rheum, Ephedra, Arnebia, Valeriana, Angelica, Orchis, Picrorhiza, Podophyllum* and *Swertia* are under threat by the activities of such notorious outsiders. Conversation with head-men of local inhabitants, especially tribal personnel of high altitude Uttarakhand Himalayas revealed that elderly persons, in spite of being uneducated and literally unaware of the concepts of biodiversity conservation and sustainable development, are the real sentinels and protectors of the rare species. The head-men are curing all sorts of ailments of their people by collecting wild medicinal plants available at nearby places in the forests. They strongly believe that the plants being utilized by them are the gifts of their Gods and they are the natural custodian of all those herbs, and as such, they pluck only a minimum quantity of these herbs for their uses without damaging their sustainability. Obviously, their traditional belief comes in the clash with government laws regarding biodiversity conservation which are barring them from entering into the protected areas of the Uttarakhand Himalayas as well as infrastructural growth and development in forest areas particularly made for outsiders coming in the state as tourists and pilgrims.

IV. Discussion & Conclusion

Propagation of selected species listed as endangered/rare/ threatened and/or reaching at the verge of extinction on nearby barren wastelands coming under forest/revenue departments of the state government, and cultivation of species having market demand is being repeatedly advocated by several scientists, environmentalists, naturalists, etc. working in Uttarakhand Himalaya [16], [25]-[27]. Official Forest Department statistics from the Uttarakhand government peg illegal encroachments on forest land since 2000 over 10,000 acres. The decade from 2001 to 2010 saw 3903 hectares of this land being mercilessly stripped and gouged by the gun-toting mining operations of illegal culprits. In 2012, an additional 1608 hectares of forest was officially consigned to mining [11], [19]. Construction of a number of hydro-electric power projects even in mega-biodiversity areas and development of townships along with dams are worsening the situation. On February 26,2013, a division bench of Uttarakhand High Court ordered the removal of the structures built illegally within 200 meters of the river embankment, but the order was nagged by the Uttarakhand government to act against thousands of similar constructions along the banks and the flood plains of the state's restless rivers. The worst natural calamity of June 16, 2013 when the three great rivers of the area viz. Bhagirathi, Alaknanda and Mandakini cleansed thousands and thousands of residential and commercial constructions and killed over 20,000 pilgrims/tourists visiting the state apart from innumerable loss of people and property of the local inhabitants [28]. These peri-urban encroachments are the worrying sign for ecologically fragile areas of Uttarakhand Himalayas because carrying capacities (maximum number of persons an environment can support) of various tourist centers in Uttarakhand reached at saturation levels. Ecological fragility sets limits. Today, these limits are being violated. And therefore, it is need of the hour for judicious plans of development over the mega-diversity areas of the state.

Revenue inflows after all cannot be ignored. Since tourism contributes up to 30 percent to Uttarakhand's GDP in recent years, more and more infrastructural growth and development are in the way to facilitate the ever increasing number of tourists and pilgrims over the years. This booming economy with better life amenities and infrastructural facilities leading to rapid peri-urban expansion are creating pressure over biodiversity of the area. In circumstances, it is need of the hour to protect wild germplasm flourishing in Uttarakhand Himalayas in general and that in protected areas like National Parks, Sanctuaries, and Biosphere Reserve in particular [24], [25], [29], [30].

Uttarakhand has incredible potential of eco-tourism, but at the same time, it is a reality that most of the visitors come here with a prime motto to worship at their holy shrines. If this pilgrim-linked tourism is channelized in a proper way, it could boost economy of the area in a much better way without disturbing the level of biodiversity. In context to peri-urban expansion and encroachments, emphasis could be given on public-private partnerships and more marketing of indigenous tourism products, but without disturbing the balance of nature. The government has to develop more and more infrastructure with sufficient safety and security to cope the ever increasing number of tourists and pilgrims only on barren wastelands of the area. An effective, statutory, and unified shrine board is the need of the hour equipped with enough facilities ready to start immediate rescue operations to pilgrims and tourists in any catastrophe occurred. Since restricting the number of visitors is neither feasible nor acceptable to the public and state government, there must be a board of experts involving environmentalists, geologists, economists, management persons, etc. working in the area in collaboration with local people who may look after the ecological imbalances in the region and suggest proper remedies to the government, including impacts of peri-urban growth and expansion over biodiversity threat in Uttarakhand Himalaya.

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