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Effects of Anthropogenic Activities in High Altitude Areas of Garhwal Himalaya: An Overview

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Abstract

Garhwal Himalaya is lying between $77^0$33'5" to 80^0E longitude to $29^0$31'9" to$31^0$26'5" N latitude and is known for the home of various Rare, Endangered and Threatened (RET) species. Since last few decades uncontrolled anthropogenic activities have increased in this region. All such illegal activities posses serious threat to populations of various important species of flora and fauna. The uncontrolled pilgrimages in sacred places and nearby alpine pastures, grazing by domestic animals, exploitation of important natural flora by local unskilled collectors and their illegal collection and trade are the major activities which are increasing day by day in the region. There are no strict rules and laws for tourism and other activities to restrict their visits in high altitude areas of the region. Due to overexploitation, illegal collection and trade, a number of important plant species have been listed in endangered category in the region. A rational approach is needed to maintain the sensitivity of alpine pastures by controlling such illegal activities. If such anthropogenic activities are not controlled within time, the coming days may be very painful for the human being and biodiversity of the region. The present paper reveals the effects of uncontrolled anthropogenic activities in high altitude areas of Garhwal Himalaya

Keywords: Anthropogenic | Himalaya | climate | threat | pollution and uncontrolled |

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Introduction

Anthropogenic pressures are the disturbances caused by human induced activities on the surrounding environment. Since the beginning of human civilization, man induced pressures have influenced the forest ecosystems of the world. The worldwide destruction of floral diversity is continuing at an alarming rate due to multiplicity of causes like grazing, logging,

lopping, illegal collection of herbs, cutting of trees for fuel wood and fodder, and forest fires etc. (Prance *et. al*., 2000). Excessive pressures unenthusiastically influenced the climax assemblages and bring unsteadiness in the ecosystem (Clements, 1936) and at moderate level such activities may enhance species diversity in the community by preventing competitive exclusion by dominant species (Huston, 1979). Impacts of human activities are more devastating to land and biodiversity than those occurring naturally. A number of species have been eliminated from areas dominated by human influences. From last few decades unprecedented destruction of global forest cover have been observed (Mayaux *et. al*., 2005). In the Himalayan region, the major causes of biodiversity and habitat degradation in both within and outside protected areas are unexpected and unplanned developmental activities besides high grazing by domestic ungulates (Kala and Rawat, 1999). In Indian Himalayan region, habitat destruction, over exploitation and pollution have been identified as major causes of biodiversity loss and degradation (UNEP, 2001). Grazing by domestic animals in alpine and subalpine meadows of Himalayan region is the major challenge for the degradation of herbal diversity. It is estimated that about 100,000 to 150,000 goats and sheep grazed in the high altitude meadows of Kedarnath wildlife sanctuary during summer season of 1990 (Sathyakumar *et. al*., 1993).

Despite of inaccessibility, remoteness and limited employment opportunities, forests and other natural resources are the important source of income in this part of Western Himalaya (Malik *et. al*., 2014b). The local inhabitants of different altitudes are dependent on the forest products for their basic requirements such as grazing, timber, fuel wood, fodder and other raw materials for industries. Rapid and continuous overexploitation of valuable species has led to the degradation of natural flora in the region. In the alpine and subalpine meadows of Himalayan region, the major form of disturbances are removal of biomass in the form of grazing and uprooting, the process continues year after year and ecosystems do not get time to recover from this damage (Singh *et. al*., 1998).

Garhwal Himalaya is an extremely diverse site in the Indian Himalayan region. Numbers of sacred places are situated in this particular region. Unfortunately during the last few decades the vegetation of this region degraded rapidly due to the human interferences, like illegal collection of important medicinal and aromatic plant species, grazing by domestic animals, littering of garbage and non-biodegradable solid wastes and unaccountable pilgrimage. Devotedness and superstitious belief of pilgrims is also the biggest challenge for degradation of plant diversity in the region. Thus, the aim of present study was to provide an account on the uncontrolled anthropogenic activities in high altitude areas of Garhwal Himalaya.

1. Effect of Tourism

Tourism disturbance is a key factor of influencing community differentiation, degradation, composition and structure of

species diversity in the alpine meadows. As per Xiang and Zhang (2009) most of the floral meadow communities are under heavy and very serious disturbance with ruthless degradation around the world. In order to protect and restore the meadow communities for sustainable use and development, tourism activities must be effectively managed (Price and Kim, 1999; Geneletti and Dawa, 2009). The significant factors that are contributing to the tourism are beautiful landscapes, peaks, alpine meadows and world famous sacred places in of Himalayan region. It is true that tourism is the backbone of growth and development of mountain people. It has a number of positive and negative effects. It helps in the creation of variety of employment opportunities for locals that decline the outward migration of people from mountainous villages to metropolitan cities. Increased the communication level of local people and brought positive changes in the fundamental human behaviour. The major role of tourism in high altitude areas is the diversification of local economy, improvement of infrastructure, development of local arts, crafts and cultural programmes, improved standard of living and activation of latent. Despite of positive effects, this sector posses negative effects also. Negative effect includes destruction of forests, consumption of fire wood, pollution, endangering the ecological balances of the nutrient, water and energy systems. Hotels, roads and other constructions which burden the environment, increase the garbage and solid wastes, soil erosion, destruction of grazing lands by camp grounds and encroachment of flora and fauna in popular tourist areas. Waste dumping is a serious problem and improper disposal can be a major despoiler of the natural environment. In alpine areas, trekking tourists generate a great deal of waste. Tourists leave behind their garbage and even their camping equipments. Such practices degrade the floral diversity of meadows. Sewage is another major problem in these areas. Construction of hotels, recreation and other facilities leads to increase the sewage level and it damage the floral diversity.

Uttarakhand Himalaya is known as “Dev Bhoomi”, particularly Garhwal region is known to be a home of various saints, seekers of piece and enlightment and a preferred destination of pilgrimage since time immemorial as it hosts a number of sacred sites across the region. In Garhwal Himalaya, Badrinath, Kedarnath, Gangotri-Yumnotri, Hemkund Sahib, Rudranath and Tungnath are known for their sacred values. All these sites are also known as the home for biodiversity of flora and fauna. The most important and high value medicinal and aromatic plant species such as *Saussurea obvallata, Podophyllum hexandrum, Aconitum heterophyllum, Nardostachys grandiflora, Picrorhiza kurrooa, Rheum emodi, Angelica glauca, and Saussurea costus* etc., are found nearby alpine meadows. Currently, the status of all these species has declined in this region. Unfortunately except Hemkund Sahib, most of these sacred places lack necessary facilities of garbage and solid waste management. Uncontrolled and unplanned pilgrimage activities have increased in recent years.

Figure 1: Non-degradable solid wastes littered in the alpine meadows of Garhwal Himalaya

There is not any appropriate course of action against the peoples whose are responsible for degradation of biodiversity in the region. Government of Uttarakhand has taken initiatives in 2008 and restricted the entry of more than 150 tourists per day at the origin of the holy river Ganga in Gangotri. But the concerning authorities were not aware about the number of pilgrims visiting sacred places and nearby alpine meadows per day. If we visit these meadows we can see that lot of waste material such as polythene bags, plastic bottles, disposals, alcohol bottles etc. littered all around the visiting/ camping sites. This waste material is harmful for the biodiversity of meadows and is the main source of soil and water pollution in these areas.

2. Effect of Grazing

The current human induced changes are the major cause of glacier receding, habitat destruction and changes in vegetation composition of the alpine region of Garhwal Himalaya **(Naithani *et. al*., 2001 and Nautiyal *et. al*., 2004).** Uncontrolled and unregulated grazing in alpine meadows results in the loss of productivity, thus biotic pressure on natural ecosystem finally leads to ecological degradation. Intense grazing affects regeneration; impairs the capacity of plants growth and causing soil erosion. In high altitude ranges of Garhwal Himalaya, particular places for grazing of livestock's are not marked.

Figure 2: Grazing in alpine meadows of Garhwal Himalaya

During summer season, local inhabitants migrate from lower altitudes to alpine pastures for grazing their domesticated animals like buffalos, cows, horses, goats, sheep and large number of mules by local porters for earning their livelihood from pilgrims and tourists. Impact on alpine ecosystem is generally predicted in terms of variation in vegetation composition and invasion of species from lower altitude (Korner, 1999).

Up to some extent grazing may be proved useful for the overall growth and development of vegetation of the meadows. Grazing in high altitude areas is also the prime reason for the survival of plant species. Various attempts have been made previously to understand the impact of long term grazing on vegetation composition, documentation of changes in plant population, structure, productivity and carrying capacity (Ram *et. al*., 1989; Sundriyal and Joshi, 1990; Sundriyal, 1994, 1995; Nautiyal *et. al*., 1997a, b and Nautiyal *et. al.*, 2004)). To understand the impact of grazing and ungrazing on vegetation of alpine meadows, a significant study was done at Tungnath protected area of Kedarnath Wild Life Sanctuary and one among the renowned sacred holy places of Hindus, where large herds of sheep, goats and buffalos reach every year during May–October for summer grazing. Nearly 4000–5000 sheep/goats, 50–70 buffalos and 30–40 horses and mules reach to the alpine pastures in every season and thus cause heavy grazing pressure on floral diversity as shown in figure 2. The nutrient (organic carbon, total nitrogen, total potassium and total phosphorus) cycling speed of plants get declined due to grazing pressure in alpine meadows. Rawat *et. al*. (2009) made a significant study on the annual nutrients budget for the grazed and ungrazed sites of an alpine expense in Tungnath region of Garhwal Himalaya. Nutrient concentration of some dominant species was recorded higher for the ungrazed sites compared to the grazed sites as shown in table 1.

Plant species	**Ungrazed sites**							
	Organic carbon		**Total nitrogen**		**Total potassium**		**Total phosphorous**	
	Live shoots	**Dead shoots**	**Live shoots**	**Dead shoots**	**Live shoots**	**Dead shoots**	**Live shoots**	**Dead shoots**
Carex nubigena	0.50 ± 0.17	0.39 ± 0.11	1.57 ± 0.29	2.29 ± 0.20	0.07 ± 0.01	0.10 ± 0.00	0.003 ± 0.000	0.004 ± 0.000
Danthonia cachymeriana	0.55 ± 0.11	0.51 ± 0.27	2.44 ± 0.28	0.82 ± 0.46	0.11 ± 0.01	0.04 ± 0.02	0.004 ± 0.001	0.001 ± 0.000
Geum elatum	0.69 ± 0.07	0.42 ± 0.20	3.16 ± 0.24	1.86 ± 0.63	0.14 ± 0.01	0.08 ± 0.03	0.005 ± 0.001	0.003 ± 0.001
Polygonum macrophyllum	0.34 ± 0.03	0.42 ± 0.12	2.70 ± 0.17	2.41 ± 0.15	0.12 ± 0.01	0.10 ± 0.01	0.005 ± 0.001	0.004 ± 0.000
Potentilla cuneata	0.35 ± 0.05	0.23 ± 0.11	2.22 ± 0.14	2.58 ± 0.19	0.10 ± 0.01	0.11 ± 0.01	0.004 ± 0.000	0.004 ± 0.000
Trachydium roylei	0.74 ± 0.04	0.22 ± 0.11	2.41 ± 0.15	2.14 ± 0.12	0.11 ± 0.01	0.09 ± 0.01	0.004 ± 0.000	0.004 ± 0.000
Composite sample	0.39 ± 0.15	0.30 ± 0.10	2.06 ± 0.40	1.68 ± 0.48	0.11 ± 0.03	0.06 ± 0.02	0.004 ± 0.001	0.002 ± 0.000
Grazed sites								
Carex nubigena	0.62 ± 0.12	0.26 ± 0.05	1.39 ± 0.24	2.01 ± 0.39	0.06 ± 0.01	0.09 ± 0.02	0.003 ± 0.001	0.004 ± 0.000
Danthonia cachymeriana	0.52 ± 0.11	0.16 ± 0.11	2.33 ± 0.24	0.78 ± 0.45	0.10 ± 0.01	0.03 ± 0.02	0.004 ± 0.001	0.001 ± 0.000
Geum elatum	0.71 ± 0.08	0.46 ± 0.14	2.80 ± 0.50	1.70 ± 0.58	0.12 ± 0.02	0.07 ± 0.03	0.005 ± 0.001	0.003 ± 0.001
Polygonum macrophyllum	0.36 ± 0.05	0.35 ± 0.13	2.51 ± 0.26	2.32 ± 0.11	0.11 ± 0.01	0.10 ± 0.00	0.005 ± 0.001	0.004 ± 0.000
Potentilla cuneata	0.40 ± 0.05	0.24 ± 0.07	2.16 ± 0.14	2.43 ± 0.16	0.09 ± 0.01	0.11 ± 0.01	0.004 ± 0.000	0.004 ± 0.000
Trachydium roylei	0.72 ± 0.03	0.33 ± 0.12	2.27 ± 0.13	2.08 ± 0.08	0.10 ± 0.01	0.09 ± 0.00	0.004 ± 0.000	0.004 ± 0.000
Composite sample	0.35 ± 0.13	0.25 ± 0.11	1.43 ± 0.50	1.13 ± 0.14	0.09 ± 0.03	0.05 ± 0.01	0.004 ± 0.001	0.02 ± 0.000

Table 1: Mean nutrient concentration (% of dry weight) of some dominant plant species in ungrazed and grazed sites (Rawat *et. al*., 2009)

3. Effect of Misbeliefs

Unique tradition is seen among devotees to collect the flowers from alpine pastures to offer to the deity in the nearby temples. For example, critically endangered Brahmkamal (*Saussurea obvallata)*, the state flower of Uttarakhand known for its medicinal properties and charming scent, is also collected from its

natural habitats on the name of deity. Each year a large population of many important and critically endangered species were uprooted by the devotees to pray the God. Even though the shopkeepers running their business near the sacred places, fetches charming and scanty herbal species from alpine pastures and put up for sale to pilgrims in the name of "Pooja Samagri" or used for decoration purposes for their own profit. It is estimated that around holy temple of Tungnath about 60000-80000 plants of different species of herbs are uprooted by the local businessmen every year during summer season for Pooja Samagri. Seed setting and genetic diversity of various plant species is affected due to uprooting of flowering parts which lead to decline in the natural population of these species. These superstitious belief increases the challenges for the existence of floral diversity in the region. Some of the uprooted plants offered with Pooja Samagri are shown in the figure 3 as given below.

Figure 3. Exploitation of various plants for "Pooja Samagri"

4. Effect of Illegal collection and trade

Collection and trade of medicinal and aromatic plants is an age old tradition throughout the world particularly in Himalayan region (Chauhan *et. al*., 2013). Illegal collection and trade is continuous in high mountainous regions especially in Uttarakhand Himalaya. Even after ban imposed by government on such illegal collection and trade, every year thousands of plants of endangered species are uprooted from alpine pastures. Over 90% of the market demand of medicinal and aromatic plants is met from the wild. It is estimated that to get one kg dry weight of *P. kurrooa* (high value medicinal species*)* as many as 300 to 400 individual plants are uprooted (Uniyal *et. al*., 2011). People settled in high altitude areas of Himalayan region have limited sources for earning money except few cereal crops grown in their small land holdings. Due to the low agriculture production, lack of industrial development, poverty and unemployment, peoples migrate to exploit biodiversity from high altitude areas to improve their socioeconomic status. Illegal collection of MAPs provide extra source of income to compensate the low agricultural production to some extent. It has been estimated that many rural communities derive as much as 10-50% of their household income from the sale of the forest products (Olsen and Helles 1997; Kuniyal *et. al.,* 2005; Williams *et. al.,* 2005; Adhikari *et. al.,* 2007; Christensen and Heilmann-Clausen, 2009). Good profit at each channel encourages peoples to involve in illegal collection and trade. Sometimes, local people obtain advance cash from traders for

their daily requirements. Annual cash income in itself proved to be positively correlated with income from wild products (Olsen and Larsen 2003; Pandit and Kumar 2010). In this context, Chauhan *et. al*. (2013), conducted an intensive survey in different sites of Garhwal Himalaya *viz*., Har-Ki-Doon, Dayara, Panwalikantha, Madhmaheshwar and Joshimath on trade of threatened medicinal and aromatic plants from wild. Information was collected on trade, channels involved and profit at each level. They found that total eighteen species are in active trade from study areas. Percentage of profit varied at each site and species level. Demand of important species like *Aconitum heterophyllum*, *Nardostachys jatamansi* and *Picrorhiza kurrooa* is much higher than supply available in all studied areas as shown in table 2. Traders earn maximum percentage of profits whereas collectors also received good profit, due to which they were engaged in illegal collection from the wild.

Sites	Quantity of selected species (qt)				
	Aconitum heterophyllum	***Aconitum balfourii***	***Nardostachys jatamansi***	***Picrorhiza kurrooa***	***Rheum spp.***
Har-Ki-Doon	1.0	33	18	5.5	18
Dayara	0.45	50	4.25	10	6
Panwali Kantha	1.50	25	18	48	18
Madmaheshwar	1.35	32	39	60	13
Joshimath	0.35	12	35	32	32
Total	**4.65**	**160.0**	**114.25**	**155.5**	**87.0**
Demand	24.0	109.0	317.0	470.0	91.0
Deficit	19.32	29.0	202.75	314.5	4.0

Table 2. Quantity (qt), demand and deficit of selected MAPs in Garhwal region of Western Himalaya (*Courtesy: Chauhan et. al. 2013)*

From the above mentioned table it is clear that the illegal collection and trade of important medicinal and aromatic plant species is increasing at an alarming rate in high altitude regions of Garhwal Himalaya. The data indicate that demand of important species is very high but the supply rate is too low. High profit at each stage through illegal collection and trade encourages local people to exploit the important plant species from the wild.

Figure 4: Collection of MAPs from wild in the name of Deity

Discussion and Conclusions

The present piece of study concludes that the uncontrolled anthropogenic activities such as grazing, hunting, illegal collection, unplanned tourism and increase in infrastructures poses serious threat to biodiversity of high altitude areas. Improper biodegradable and non-biodegradable waste dispersion and excessive garbage on pilgrimage sites in alpine meadows not only pollute the habitat of plants but also pollute the related river springs. It is necessary to develop and enforce guidelines for check the disposal of garbage particularly non-degradable waste, limit and properly plan the infrastructure growth in the hilly shrines so that they are facilitated with well municipal services. Plastic should be banned in pilgrimage and alpine camping places, several states of India like Himachal Pradesh has taken

the strict initiative for banning the plastics. There should be potable water at various locations in routes so that people can fill their containers, as the plastic bottles are the major waste in alpine pastures (Bugyals) and holy shrines.

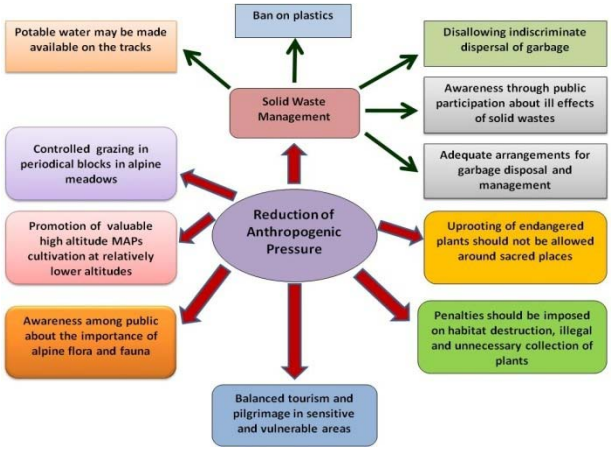

Figure 5: Control measures for the reduction of anthropogenic pressures in Himalayan meadows and sacred places

Awareness and capacity building among the local inhabitants would greatly help in managing the waste it proves very effective on the tracks of Valley of Flowers and Hemkund Sahib which are properly managed by public participations and initiatives taken by Forest Department of Uttarakhand. Awareness programs among the people about the status and importance of MAPs of alpine areas may helps to control the unnecessary flower collection of endangered MAPs for decoration and aesthetic purposes, which leads to more seed set in such alpine plants. Overgrazing in alpine meadows should be restricted or controlled grazing should be allowed in particular pastures on periodical basis. Cultivation of important alpine MAPs should be promoted among local farmers to reduce the pressure on their natural populations. Penalties should be imposed on habitat destruction and illegal or unnecessary collection of plants.

Various interlinked conflicts, political, social, and economic factors also affect the conservation strategies of a particular area (Alton C. Byers, 2013) and therefore all these aspects are needed to be considered for developing the strategies for declining anthropogenic pressure on alpine Himalayas.

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