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EFFECTS OF HUMAN PROXIMITY AND NOMADIC GRAZING ON THE DIVERSITY OF MEDICINAL PLANTS IN TEMPERATE HINDUKUSH

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Abstract

Over exploitation and overgrazing are considered major factors for decreasing plant species diversity. However, we do need some more exploration on the types of anthropogenic disturbances responsible for variation in species' decline among different regions. Therefore, the current study was conducted in a temperate Hindukush region of Pakistan with the aim to assess human settlements' pressure on the diversity of medicinal plants. Field data was collected from 15 plots, of which 5 plots each were randomly selected at three distant locations in derived woodland forest. Near to community plots were heavily disturbed due to natives' proximity, 2 kilometer away plots from the native community were moderately disturbed, while 4 kilometer away plots were under the disturbance regime from temporary settlers (Nomads). We have found all 10 studied medicinal plant species at 2 Km distance followed by 8 species found at 4 km distance. Economically important species such as *Bergenia ciliata, Paeonia emodi, Podophyllum emodi, Valeriana jatamansi* and *Viola canescens* were completely absent near village. Similarly, density (8.72 n m^{-2}) and species richness (8.2 n 40 m^{-2}) were found significantly highest at 2 km distance than other locations. Detrended Correspondence Analysis (DCA) showed that among forest stand structural variables, slope was the influencing variable related to the density of only *Bergenia ciliata*. In conclusions, moderate disturbance is associated to increase in the diversity of medicinal plants, while high anthropogenic pressures the otherwise. Hence, effective management strategies may be adopted to conserve such precious eroding flora.

Key words: Anthropogenic disturbance, Derived woodland, Flora, Livelihood, Conservation.

Introduction

In the last few decades, medicinal plants remained a focal issue for policy makers, conservationists, foresters and non-government organizations especially in the developing countries (Hamilton, 2004). This attention is due to the unsustainable ways of collecting and processing medicinal plants. Most of the rural communities utilize medicinal plants for domestic and commercial purposes. They use herbal medicines as an alternative to allopathic medicines due to limited purchasing power and lack of modern health facilities. Increasing poverty in developing countries is highly associated with increasing dependence on non timber forest products such as medicinal plants (Rasul *et al*., 2008; Gul *et al*., 2012). Moreover at commercial level, the harvesting of medicinal plants is a common practice in order to receive economic gains and support rural livelihood. People collect medicinal plants from their nearby vicinities and sell them to middle men, local traditional practitioners and or to local markets. Studies in different regions have argued that areas near human settlements are mostly less diverse with native flora, which is mostly due to over collection and grazing activities (Adnan *et al*., 2014). Deforestation, over collection and grazing has already been identified as major threats towards plants extinction in many studies (McEvoy *et al*., 2006; Shinwari & Qaiser, 2011).

The Hindukush region is one of the 10 mega-centres and part of one of the 34 biodiversity hotspots in the world (Sharma & Chettri, 2005). The medicinal plants of this region are under pressure of urbanization and exploitation of raw materials by pharmaceutical companies (Tandon, 1996; Dhar *et al*., 2000). The unsustainable collection practices in Hindukush forests have resulted in decreasing diversity of medicinal plants. Many medicinal plants been already disappeared and several other are vulnerable or endangered. Yet, for all its biological diversity, it is among the least known of the world's mountain systems. Thus the most pressing challenge is to conserve biodiversity and improve the livelihood of dependent communities in the region (Sharma & Chettri, 2005; Gilani *et al*., 2011).

This study has been carried out in the Miandam valley of northwest Pakistan, which is stretched along Hindukush region and endowed with diversity of medicinal plant species. As one of the chief non timber forest product (NTFPs), local people harvest over 200 medicinal plants species (Adnan *et al*., 2012) that are generally utilize in traditional medicines and traded to national and international markets for income generation (Ahmad, 2003). Medicinal plants are considered to be an essential component for the rural livelihood in the region. Most forests in the study area are state owned and are subjected to nomadic grazing in summers. The local owners give their private pastures on lease to these nomadic grazers, who temporarily reside at high altitude forests, rare their goats and collect medicinal plants. Therefore, the local flora is degrading both from permanent human settlements and areas designated to nomadic grazers. The expanding human population and free grazing has accelerated the rate of extraction of the local forest resources particularly medicinal plants. The practice of leasing pastures to nomadic grazers on rent *(Qalang)* together with local extraction needed investigation. Therefore, this research study was designed with objectives to (i) asses variations in the diversity of selected medicinal plant species at varying distance gradients from human settlements, (ii) examine the effect of free grazing on medicinal plants diversity and its determinants, and (iii) propose remedial measures for the conservation of medicinal plants.

Methods and Materials

Study area: Miandam valley is a summer resort located in District Swat, Khyber Pakhtunkhwa province, Pakistan (Fig. 1a). Geographically, the area can be traced on 35°, 02′ N and 72°, 33′ E northwest of the country and lies in the Hindu Raj series of Hindukush mountain region (Rehman, 2002). Mean annual precipitation ranges from 1000 mm-1250 mm. Mean monthly temperature remains below 10ºC for about 6 months in a year. The valley consisted of 4,388 ha area (Adnan *et al*., 2006) with the altitude ranges from 1400 m asl (meter above the sea level) (*Fatehpur Tehsil*) to 3800 m asl (*Ghojaro Sar*). Miandam valley occupies hamlets (*Mozajat*) no. 46, 47, 48, 49 and 50 i.e. *Barhampatai, Sanai, Kherabad, Miandam* and *Jukhtai*, respectively on the revenue index map of Swat District (Sher & Hussain, 2007). Miandam valley has a population of 19,516 living in 2,006 houses (Adnan *et al*., 2006). About 3000 people are earning 25% of their total income from the sale of medicinal plants (Begum & Adnan, 2006). Ethnographically, Gujars (Indian Aryans) and Yousafzai (Pukhtoon) are the two main tribes settled in the area. Major agricultural crops are wheat, potatoes, maize and rice.

Conservation issues: The Miandam forests are state owned protected forests (Nafees & Asghar, 2009), in which all acts (grazing, grass cutting, fuelwood collection etc) are allowed until prohibited by the government (Sher *et al*., 2005). The study area has a diverse physical-geography comprising valley, plains and small watersheds with steep to moderate slopes. Phytogeographically it comes under the Sino Japanese region and has established the moist temperate type of forest mainly temperate sub alpine and alpine composition. Variations in altitude, moisture, soil, temperature, topography and vegetation were the factors important for the classification of valley into alpine region, blupine-black oak forests, fir-spruce forests olive-white oak forests and tree line iron oak forests (Rehman, 2002).

The important conifer species are *Pinus walliciana, Abies pindrow* and *Picea smithiana.* Forests of Miandam are abundant with medicinal plant species that are used for various home ailments and served as a vital source of cash income for the surrounding rural population. Thousands of peoples are living below the poverty line of US1$ per day and relay on natural forests for their livelihoods. Miandam valley is one of the vulnerable regions from ecological point of view, because of rapid forest loss, land sliding, flooding, soil erosion, land degradation and other natural calamities (Akhtar *et al*., 2013).

Due to the high rate of deforestation (6.13%) in the region, it has been estimated that if effective measures for sustainable forest management and resource use are not taken, the forest stock in the area will vanish by the year 2025 (Khan & Khan, 2009). This will have dire consequences for the local environment as well as for the poor's livelihoods. In addition, it will lead to a chain of adverse ecological problems and the natural ecosystem will be severely disrupted. At lower elevation (1400-1800 m asl) near the habitations, there is drastic reduction in forest cover from 28.68% in 1978 to 2.12% (Khan, 2005). The extraction of timber and other non-timber products coupled with free grazing of animals have caused a severe degradation of these forests. Main forest products are timber wood, fire wood, bush food, livestock products, pine needles, morals, wild honey, walnut, medicinal plants, furniture and antique carvings etc.

Medicinal plants: Mostly children and women are involved in the collection of medicinal plants (Adnan *et al*., 2012). Besides the local residents, nomadic grazers bring approximately 40,000 goats each year to the area and collect different medicinal plants. The nomadic sellers and natives either use these plants for self use or sell in the village markets to the intermediaries (middle men) in order to earn cash income. The intermediaries in the village markets (Bazar) sell these medicinal plants to whole sellers in the main city markets. Whole sellers either provide medicinal plants to local herbal industries or export to other countries. There is a chain of medicinal plants from collection to marketing involving a number of stake holders (Fig. 2). Excessive degradation of forest and subsequent effects on medicinal plants is due to over collection and overgrazing in the area. Nearly 50 % of the medicinal plants in Miandam valley are reportedly now endangered. Moreover, the indigenous knowledge has also been reported threatened by modernization (Mehmood *et al*., 2013).

For this study, ten medicinal plants were selected as target species. Selection criteria were high market value, relatively easy identification in the field, multiple local uses, stand for different categories of vulnerability and availability in derived woodland. Derived woodland is a forest-use type, which can be classified as a forest under high grazing pressure, fodder collection and medicinal plants harvesting (Putz & Redford, 2010). Selected medicinal plant species are *Bergenia ciliata* (Haw) Stermb, *Bistorta amplexicaulis* (D. Don) Green, *Geranium wallichianum* D. Don, *Paeonia emodi* Wall, *Swertia chirata* Buch Ham, *Gallium aparine* L, *Podophyllum emodi* Wall, *Plantago lanceolata* L, *Valeriana jatamansi* Jones and *Viola canescens* Wall ex Roxb. Species names and their families' names were corrected according to flora of Pakistan and www.tropicos.org. Most of these species are moderate to highly vulnerable. Data on these medicinal plants such as part use, NTFPs use, vulnerability status and harvest gap required for parts collected was collected from the available literature (Sher *et al*., 2005; Adnan *et al*., 2006; Sher & Hussain, 2007).

Study sites and experimental design: Field work was conducted from June 2009 to September 2009. For this study, field data was collected from 15 plots, of which 5 each were randomly selected at three locations in the derived woodland on a Geographical Information System (GIS) based map (Fig. 1b). Locations were separated from each other by their respective distance from the native settlements. First location was in the proximity of village, second was at 2 Km from the village and third location was at 4 Km from the village. Nomadic grazers were found at 4 Km distance, which come in summer season each year from May to August. ILWIS version 3.4 was used for choosing random sample points on the study area map (Anon., 2007). This was done by selecting two random values on X and Y axis and the intersection point representing the sample point. Each random point represented the center of each sample plot. Plot selected for data collection had mostly northern aspect and lay on inclines ranging from 22-24% (Table 1).

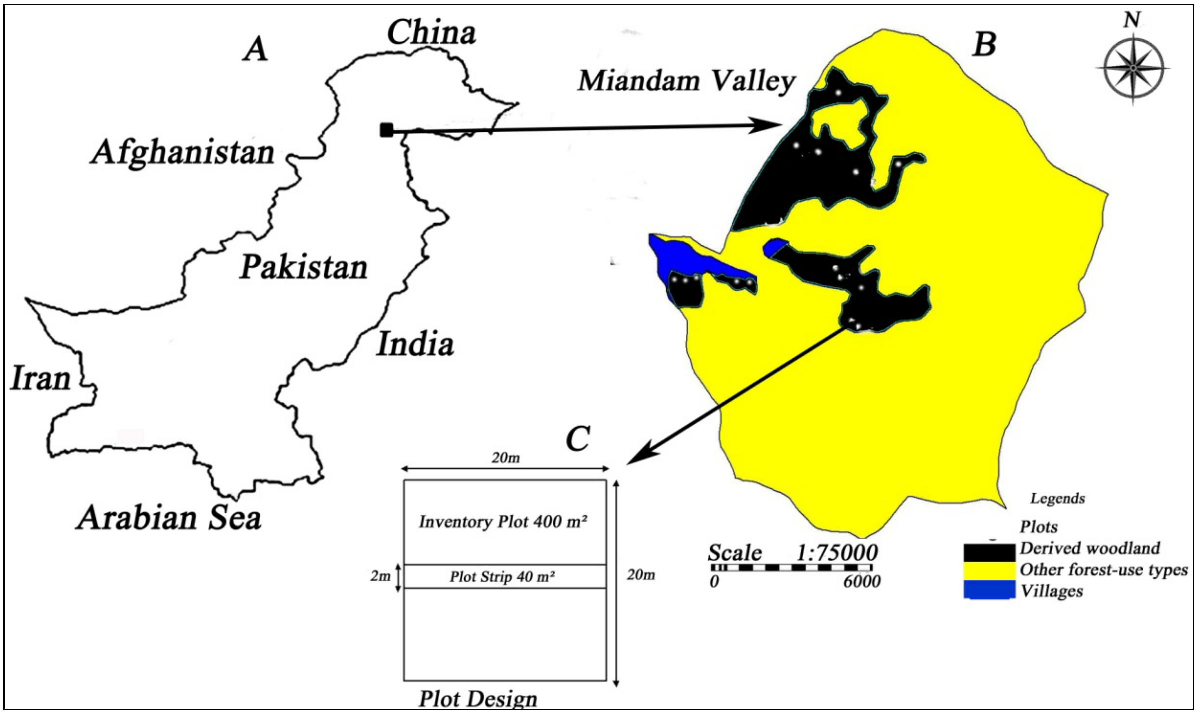

Fig. 1. Map of the study area, forest-use types and plot design. (a) Pakistan and the location of the study region. (b) The study region with Miandam valley and randomly selected study plots in derived woodland (dots). (c) Plot design; includes inventory plot for trees (400 m^2) and plot strip for medicinal plants (40 m^2).

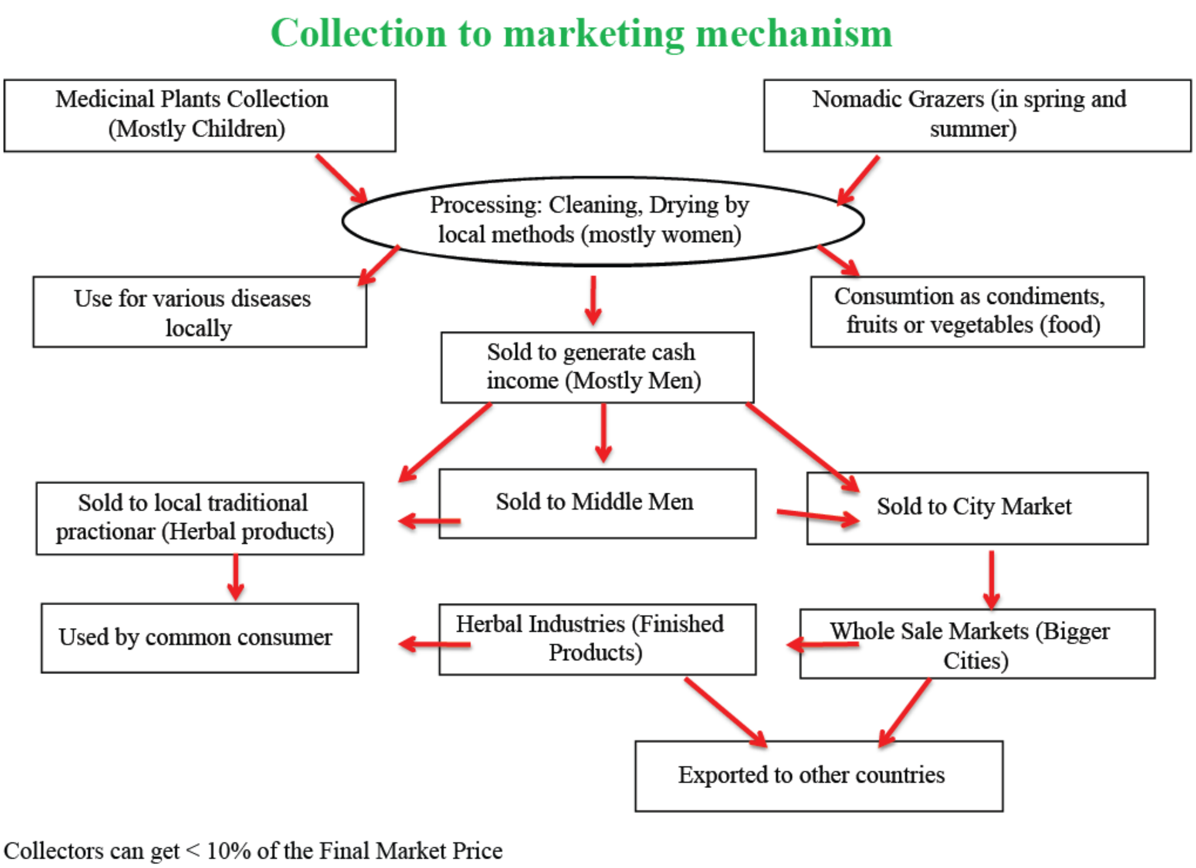

Fig. 2. Marketing chain of medicinal plants.

Table 1. General attributes on the study plots and tree stand structural variables. Mean and standard error, n=5 plots at each distance.

Attributes	Near village Mean ± SE	2 km distance Mean ± SE	4 km distance Mean ± SE	Kruskal-Wallis test
History	Uncontrolled grazing, high fodder collection and over collection of medicinal plants	Little grazing and fodder collection. Protected since 4 years	Uncontrolled grazing, over medicinal plants collection	
Altitude of study plots (m asl)	1778 ± 15.02	2152.4 ± 12.72	2337.8 ± 23.7	$p < 0.01$
Slope (%) (mean)	24 ± 5.78	22 ± 4.35	22 ± 3.74	Ns
Tree and stand structural characteristics				
Total number of tree species	6	6	5	
Diameter at breast height DBH (cm)	16.3 ± 1.52	21.87 ± 1.88	24.02 ± 1.76	$p < 0.05$
Basal area (m^2 ha^{-1})	1.56 ± 0.28	3.36 ± 0.59	7.53 ± 1.65	$p < 0.05$
Stem density (≥10cmdbh) (n ha^{-1})	75 ± 19.33	80 ± 9.34	135 ± 16.93	Ns
Tree Shannon index, trees (H$'$)	0.72 ± 0.1	0.71 ± 0.08	0.69 ± 0.07	Ns
Tree Shannon Evenness (E)	0.93 ± 0.07	0.92 ± 0.03	0.81 ± 0.06	Ns
Tree species richness (no 400 m^{-2})	2.2 ± 0.2	2.2 ± 0.2	2.4 ± 0.24	Ns

"m asl" indicate meter above the sea level. Ns denotes non significant

Table 3. Medicinal plants (herbs). Part use* include 1) leaves, 2) whole plant, 3) roots and tubers, 4) flowers, 5) seeds and or fruits. NTFP uses include 1) medicinal, 2) fodder, 3) ethnoveterinary use, 4) vegetable, 5) insecticide, 6) fruit. Vulnerability*** and harvest gap required for part collected**** (Sher *et al*., 2005; Adnan *et al*., 2006; Sher & Hussain, 2007). Market Prices are recorded at local level and then converted into US dollars (USD).**

Botanical name	Family name	Local names	Part use*	NTFP uses**	Vulnerability***	Harvest gap required for part collected****	Market Price (USD)
Bergenia ciliata Sternb. Green	Saxifragaceae	Makanpath	1,3	1,2,3	Moderate	3 years	2.6
Bistorta amplexicaulis (D. Don)	Polygonaceae	Anjabar	1,3	1,2,3	Moderate	1 year	0.6
Galium aparine L.	Rubiaceae	Kochan	2	1,2,3	Low	-	1.2
Geranium wallichianum D. Don ex Sweet	Geraniaceae	Srazela	1,3	1,2,3	Moderate	-	2.2
Paeonia emodi Wall. ex Royle	Paeoniaceae	Noorealam	3,4,6	1,3,4	Moderate	2 years	2.1
Plantago lanceolata L.	Plantaginaceae	Ispaghol	2	1	Moderate	1 year	1.2
Podophyllum emodi Wall. ex Hook. f. & Thomson	Berberidaceae	Kakora	3,5	1,6	Moderate	2 years	5.2
Swertia chirata Buch. -Ham. ex D. Don	Gentianaceae	Chirata	2	1,3	Low	-	1.5
Valeriana jatamansi Jones.	Valerianaceae	Mushkebala	1,3	1,2,5	High	2 years	4.6
Viola canescens Wall.	Violaceae	Banafsha	2	1,2,4	High	1 year	12.4

Plot and estimation designs: Each plot has a tree inventory plot of 20 x 20 m (400 m^2) and a plot strip of 20 x 2 m (40 m^2) within each inventory plot. Data on medicinal plants was collected in the plot strip (Fig. 1c). All plots were laid down on the contour line with slope correction. Tree with more than 10 cm diameter at breast height (DBH) and species identity were documented, while basal area, richness and stem density were measured at plot level. Trees' Shannon–Wiener diversity index $H^{/}$ (Magurran, 2004) was determined each for all inventory plots.

Different variables of understory medicinal plants were studied such as density, richness, frequency, biomass and cover. Visual estimation method was followed for the collection of data on medicinal plants cover in percentage. Species density was assessed by counting the number of individuals of a species. Species richness was estimated by counting the number of species. Similarly, Shannon diversity index $H^{/}$ per plot strip was derived for the target medicinal plant species. Medicinal plants frequency was recorded as the percentage of sub-plots that included the target species. Standard procedure was followed proposed by Curtis & McIntosh (1951) for the estimation of frequency, density and cover. Biomass of a medicinal plant species (fresh and dry, above and below, g m^{-2}) was calculated by selecting three individual plants in proximity to three random points in a plot strip and multiplying their average weight (above or below) with the density of that particular plant species. Plants were shade-dried for 15-30 days and weighed to record dry biomass. Market prices were recorded at local level and then converted into US dollars (USD).

Statistics: Mean values differences of forest tree stand structural variables and understory medicinal plant variables among three given forest locations were tested by applying Kruskal-Wallis test. Statistical analysis of medicinal plants was done both at species level and as a whole. We have used Detrended Correspondence Analysis (DCA) in order to recognize the most influencing variable among forest stand structure possibly related to the densities of medicinal plants. Therefore, forest tree stand structure variables were subjected to standardization to guarantee each variable gets equal weight. DCA is based on the assumption of normal distribution; therefore, data on the medicinal plants' densities were logarithmically transformed. DCA and statistical tests were carried out by using PC-ORD 5.06 (McCune & Mefford, 1999) and SPSS version 16.0 (Anon., 2007), respectively.

Results

Forest tree stand structural variables among three locations: There was a gradual increase in the altitude of three locations. Plots at 4 km distance have had significantly highest mean altitude (2337.8 m asl) in comparison to lowest altitude (1778 m asl) recorded for near to village plots. Similarly, mean tree basal area was also significantly highest (7.53 m^2 ha^{-1}) on plots at 4 km distance from the village, intermediate (3.36 m^2 ha^{-1}) on plots 2 km distance from the village, while lowest (1.56 m^2 ha^{-1}) on plots near to village. More similar trends at the three different locations were shown by tree DBH. All other variables showed no significant difference among the three locations (Table 1).

Medicinal plants variables in the three locations: All 10 species were found at 2 km distance followed by 8 species found at 4 km, while only 5 species encountered near to village. Similarly, density (8.72 n m^{-2}), species richness (8.2 n 40 m^{-2}) and Shannon diversity index (1.75) were observed significantly highest at 2 km distance. All these variables were observed intermediate on plots at 4 km distance and lowest on plots near to village (Table 2).

Densities of most individual medicinal plants were also significantly highest at 2 km distance plots across the three locations. *Bergenia, Paeonia, Podophyllum, Valeriana* and *Viola* were found almost absent near village. Moreover, frequencies of most plant species such as *Geranium* and *Plantago* were also found highest at 2 km distance in comparison to 4 km plots and near to village plots (Fig. 3). Overall trend of medicinal plants variables was 2 km plots > 4 km plots > near village plots.

Medicinal plants uses and market prices: All the targeted medicinal plants were using as ethnomedicines in the study area. Species such as *Bergenia, Bistorta, Galium, Geranium, Valeriana* and *Viola* were also used as fodder (Table 3). *Valeriana* and *Viola* are recorded as highly vulnerable species the in the area. Among all the species, the highest market price was observed for *Viola canescens* (12.4 USD kg^{-1}) followed by *Valeriana* (5.2 USD kg^{-1}) and *Podophyllum* (5.2 USD kg^{-1}).

Table 2. Variation of studied medicinal plants on the whole between three distances.

Variables	0 Km Mean ± SE	2 Km Mean ± SE	4 Km Mean ± SE	Kruskal-Wallis test
Total number of species	5	10	8	
Density (n m^{-2})	0.55 ± 0.15	8.72 ± 1.48	2.75 ± 1.23	$p < 0.01$
Species richness (n 40 m^{-2})	2.6 ± 0.4	8.2 ± 0.66	4 ± 0.55	$p < 0.01$
Dry weight above ground (g m^{-2})[a]	2.04 ± 0.84	27.01 ± 2.43	3.83 ± 1.41	$p < 0.01$
Dry weight below ground (g m^{-2})[a]	1.83 ± 1.15	28.59 ± 1.65	3.32 ± 1.19	$p < 0.01$
Shannon index, $H^{/}$	0.74 ± 0.13	1.75 ± 0.11	1.15 ± 0.11	$p < 0.01$
Shannon evenness	0.81 ± 0.09	0.84 ± 0.04	0.81 ± 0.06	Ns

[a] Dried according to local methods. Ns denotes non significant
Mean and standard error, n=5 plots at each distance.

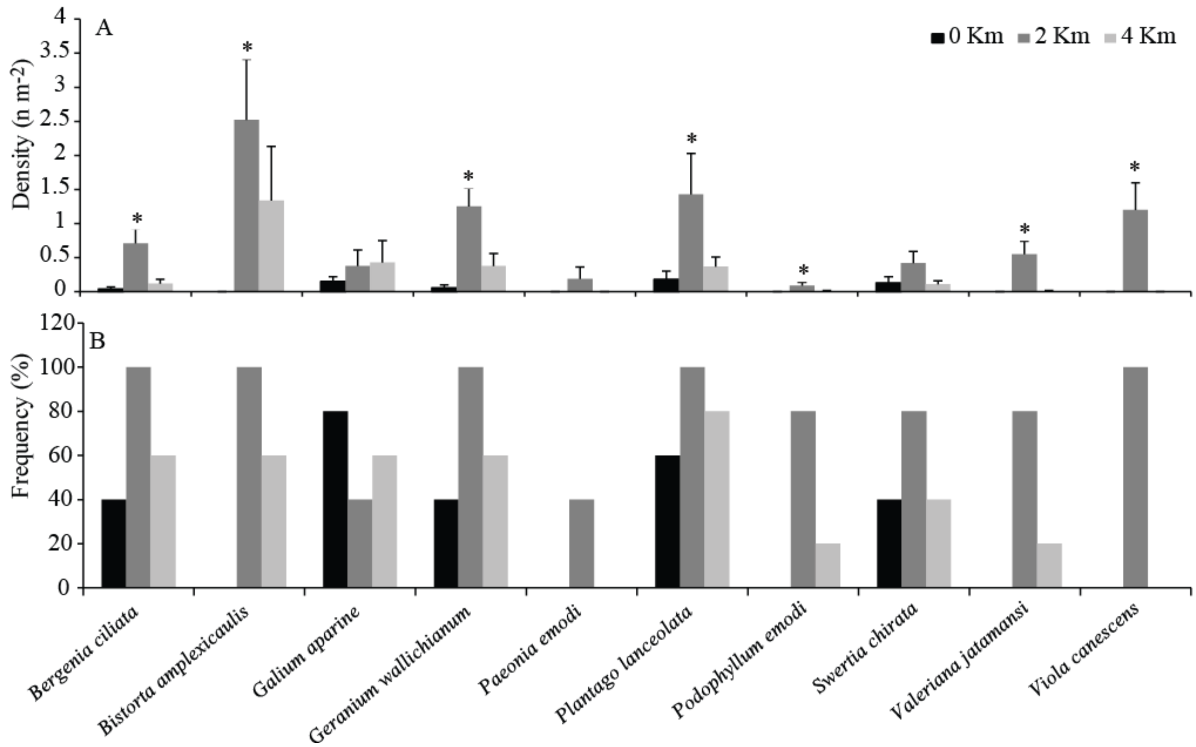

Fig. 3. Species-specific densities (A) and frequencies (B) of the studied medicinal plants on three distances. n = 5 plots per distance; * indicates significant differences at p<05, Kruskal-Wallis test.

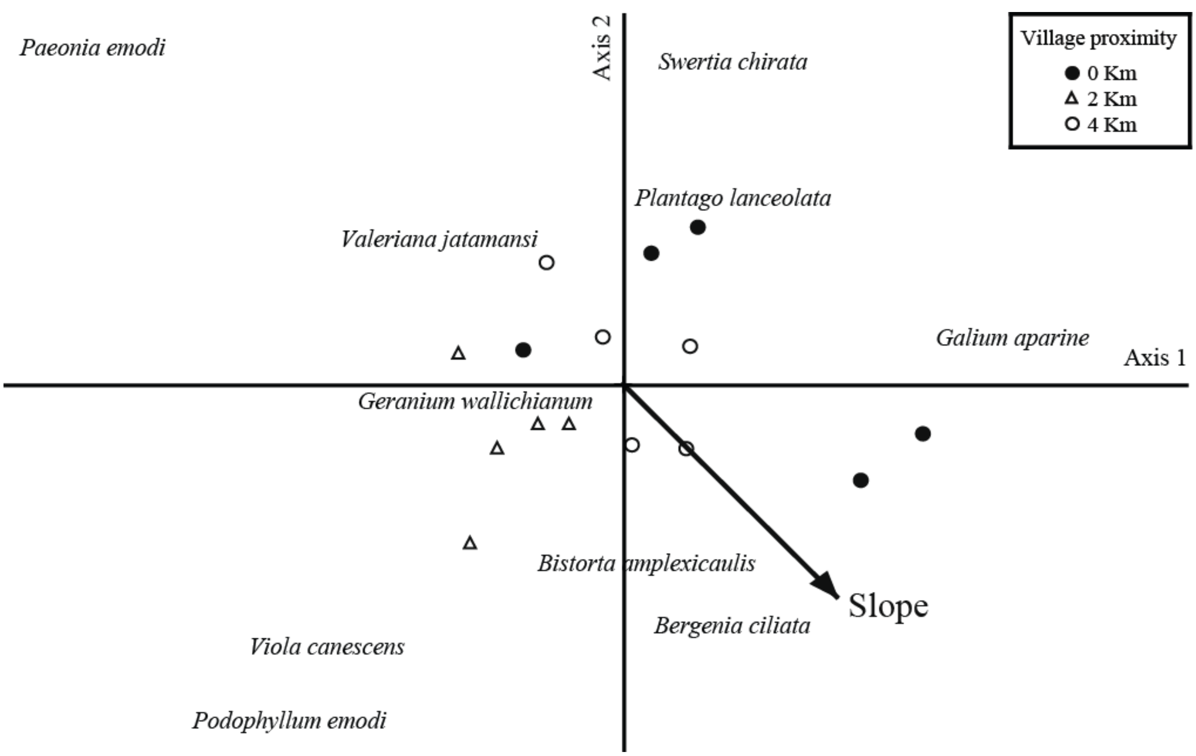

Fig. 4. Detrended correspondence analysis (DCA) for the response of medicinal plant species densities to slope in three sites based on village proximity. Matrix consisted of 15 plots, 10 Medicinal plants and nine forest stand structural variables. Axis 1: eigenvalue = 0.22, explained variance = 39%. Axis 2: eigenvalue = 0.12, explained variance = 14%. Correlation threshold $r^2 > 0.18$; Vector scaling = 326. Axis 1 did not show any significant correlation with the forest stand structural variables. Significant correlations (Spearman) have been only observed for slope ($r = -0.51$; $p<0.05$) with axis-2. In medicinal plants, only *Bergenia ciliata* ($r = -0.68$; $p<0.01$) showed significant correlation with axis-2.

Effect of forest stand structural variables on the densities of medicinal plants: DCA results (15 plots of three locations) showed that axis 2 (eigenvalue = 0.12) was only correlated to slope (r = -0.51; $p<0.05$) among forest stand structural variables. For medicinal plants, axis 2 showed only significant correlations with the density of *Bergenia* (r = -0.68; $p<0.01$). This indicates that *Bergenia*'s density strongly increased with increasing slope (Fig. 4).

Discussion

This study reveals that medicinal plants are under the heavy pressures of grazing and over-collection in the study area. Although, plants have fundamental role in improving the livelihood of mountainous dwellers, yet they are not properly managed.

Forest stand structural variables: The present study showed that among all the forest stand structural variables, basal area was found significantly reduced near to the villages as compared to sites located far away from permanent settlements. The possible reason could be high level of disturbance near community. However, the three sites differed in their responses to disturbances. Decline in total basal area and stem density with disturbance level is agreed with earlier findings (Bhuyan *et al*., 2003; Ramirez *et al*., 2001). The anthropogenic pressures like gradual and consistent increase in the extraction of fuel-wood and fodder are the major factors for reduction in basal area of tree species in the region. Bhuyan *et al*., (2003) indicated high disturbed sites having low tree density as compared to little disturbed sites. Sites located away from the main community have comparatively more basal area than to sites near community due to fewer visits from the natives. Among all the forest stand structural variables slope was found to be the most influencing variables affecting the density of only a single medicinal plant *Berginia ciliata*. From these results one can infer that overgrazing and over collection are the major factors responsible for the declining and disappearance of the medicinal plants in general.

Overall density of medicinal plant: Overall the density of medicinal plants was highest at 2 km distance from the community, while much lower near to village, which might be due to human and livestock's disturbances. However, at 4 km away the disturbance become higher when nomadic grazers comes to higher altitudes for some specific months of a year. It is normally believed that a strong relationship is present between the density of plants and grazing activities. Nomads carry almost 40,000 goats to the higher altitude of pastures every year. Each nomad during their stay also collect large quantity of valuable medicinal plants worth of US $ 450, however the owner of the grazing land are not even conscious of such losses. In general the losses from nomadic grazers are alarming and could further a gravitate if the number of these people along with goats increases.

Regeneration capacity of most of the medicinal plants is very low (Oba *et al*., 2001). Similar results were also reported by Vesk & Westoby (2000) and Sher *et al*., (2005) who reported that overgrazing is directly related with the destruction of natural vegetation and also decrease the spread of species both by direct consumption and also disturbing their natural habitats. The main consequence of grazing on plant growth is the diminution of photosynthetic ability linked with the loss of leaf area. This reduces the supply of assimilated compounds to roots, seeds, developing fruits and growing shoots (Willard & Mckell, 1973; Donaghy & Fulkerson, 1997). The time of grazing with respect to the phenological stage of the plants consumed has been proposed the most important external factor affecting post-herbivory compensatory growth (Danell *et al*., 1994). The loss of leaves during the growth period results in loss of their vigour and their capacity to maintain their growth. One of the most susceptible periods in development is the seedling stage. Until they have established their root systems and photosynthetic apparatus, plantlets are extremely vulnerable to herbivory. Older plants, however, are less affected because of their ability to compensate or to increase their defenses. Plants damaged by herbivores could become more vulnerable to further attacks by other herbivores or to pathogens (Fedde, 1997). Indirect effect of nomadic grazing includes compacted soil, physical damage to seedling and soil microorganism. These damages make the soil more vulnerable to erosion and loss of fertility. Most of the plants show rare abundance in such grazing sites. It has already been observed in the study area that sites where nomadic grazing has stopped, showing better vegetation cover, improvement in medicinal plants diversity and good regeneration of pine species (Sher *et al*., 2005).

Species richness of medicinal plants: Species richness of the medicinal plants was also found higher at 2 km distance from the community as compared to near the community. At 4 km species richness was higher than near to community plots. At 2 km distance from the community the disturbance level is intermediate that favors high species richness. Several studies reported that species richness is higher at moderate or intermediate type of grazing while low at no grazing or at extreme high grazing pressure (Milchunas *et al*., 1998; McIntyre & Lavorel, 1994), and several explanations have been suggested for this relationship (Milchunas *et al*., 1998; Huston, 1979). Present study reported low species richness near community that might be due the elimination of sensitive species due to different anthropogenic and livestock disturbances.

Individual medicinal plants density and frequency: The individual targeted medicinal plants in the present study have multiple uses. These plant species are being used for the treatment of variety of ailments coupled with earning income. Densities and frequencies of individual medicinal plants have been greatly affected at all the three sites particularly near and far away from the community. Frequency of a plant is always lower when occur disturbed pattern or in patches. This will indicate non uniform distribution on the site and any indiscriminate harvest can endanger the species on the site. Some of the medicinal plants like *Bistorta amplexicaulis*, *Berginia* *ciliata*, *Poenia emodi*, *Podophyllum emodi*, *Valeriana jatamansi* and *Viola canescens* have been completely vanished near the local community and away from the community that might be due to the tremendous pressure of anthropogenic activities near community and pressure of nomadic grazers. These plants also carry very high market prices and good healing potential; therefore the locals of the region also harvest these plants unsustainably for their primary health care needs and for improving their livelihood. *Viola canescens* and *Valeriana jatamansi* are highly threatened species indicated in the studied region. Most of the targeted plants roots' are used for medicinal purposes that results in failure of plant to develop flowers and seeds and this definitely reduces the chances of their regeneration. The collectors of medicinal plants are unskilled with no proper training for the harvesting (Shinwari, 2010). They usually do improper collection, carrying and processing due to which they loss a good quantity of medicinal plants (Tariq *et al*., 2014). Additionally, the non-scientific and haphazard collection involves uprooting of the whole plant species, even if only one part is needed (Shinwari & Khan, 2000). Moreover, collectors have inadequate information about proper season of collection, suitable time of collection in the plant life cycle, rate of harvesting, maturity of plants harvested and amount of harvest. Such information is very useful both for escalating the bioactivity and sustainability of plant resources (Qasim *et al*., 2010; Ticktin *et al*., 2002). All these factors are the major reasons of such a great decline in medicinal plants' abundance and frequency in the studied region.

Market chain and trade of medicinal plants: Prices of medicinal plants increase at each step in the chain from collector to the international market. Medicinal plants collector receives very low price of the final market price. The possible reason behind it might be that the collectors have insufficient knowledge regarding the correct price of medicinal plants in market chain. Market survey revealed that district Swat is a trading center for variety of medicinal plants. It has a well developed market system, which supplies significant amount of valuable plants to various trading centers of Pakistan and abroad. It has already been reported that high marketable species are collected from northern parts of the country including Swat (Sher *et al*., 2011). Different people are involved in trade of medicinal plants i.e. middle men collect material from collectors and sell it either to small dealers or to regional middlemen. Through this chain of middlemen, the material is ultimately delivered to the wholesale dealers of big cities. Wholesalers supply the plant materials to retailers, herbal industries, pharmaceutical companies or exporters.

Conclusion and policy recommendation: The present study stated that medicinal plants in the study region are important for the local people, however are under heavy pressure of human and livestock activities. High marketable species such as *Viola*, *Valeriana* and *Podophyllum* are almost completely vanished near the village due to overharvesting and grazing particularly from natives and nomads. Forest stand structural variables were observed not responsible for such a great decline in the abundance of medicinal plants. Local community has no proper training on harvesting of medicinal flora for their primary health care needs and marketing. Urgent conservation strategies should be adopted in the studied region before medicinal plants are completely extinct. Local people should be educated regarding proper sustainable collection of medicinal plants, uncontrolled and frequent grazing should be avoided. Nomadic grazers should be prohibited during the growth seasons of medicinal plants. Awareness among the local people should be mobilized for improving their livelihood in sustainable manner. People should be motivated toward the cultivation of threatened medicinal plants.

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