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Full Length Research Paper

Edaphic Factors and Herbaceous Diversity in Lower Dachigam National Park, Kashmir Himalaya: A Comparative Analysis

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Assessment of edaphic features and herbaceous diversity was evaluated in two different sites (Site I, forest) and (Site II, pastureland) in the lower Dachigam National Park of Kashmir, Himalaya. The study was done on seasonal basis and the results revealed higher trend for edaphic factors at Site I (moisture content, 31.22%; organic carbon, 4.33% and total nitrogen, 0.33%). However, soil temperature varied from (6 to 25°C) at Site I. pH showed acidic (5.41, Site I) to nearly neutral kind of nature (6.91, Site II). Diversity index (H′) showed higher trend during summer season at both sites. Dominance index showed inverse relationship to diversity index (H′) at both sites. Richness index depicted maximum value in spring (Site I) and summer (Site II). Equability or evenness index showed highest value at Site I (winter) and Site II (summer). Comparatively average values showed higher trend at Site I in Shannon diversity (Site I = 2.655, Site II = 2.435), richness index (Site I = 3.297, Site II = 2.652) and equability index (Site I = 0.915, Site II = 0.852). Dominant species based on frequency and density at Site I were *Fragaria nubicola*, *Poa annua*, *Stipa sibirica* and *Trifolium pratense* whereas Site II was dominated by *Cynodon dactylon*, *Origanum vulgare*, *Salvia moorcroftiana* and *Thymus serphyllum.* Maximum similarities between the two communities were recorded in spring and minimum in winter season. The study concluded that seasons have great influence on edaphic factors and species diversity. During spring and summer season an increase in species diversity was observed which declined as autumn and winter approached due to multitude of factors. The study recommended urgent need for seasonal monitoring of soil characteristics and plant diversity in the two selected sites.

Key words: Dachigam, diversity, forest, grazing, seasons, species.

INTRODUCTION

The pressure on natural resources is going to increase undoubtedly in the future because of the growing world's population and the concomitant need to meet the increasing demands while promoting economic growth. Managing the land in order to ensure that the resources used by all sectors of human activities will still be available for generations to come is an important issue on the discussion of the human use of the environment (WCED, 1987). Modification of the natural habitats due to growing human population, transportation and other processes results into accelerated biological invasion has been occurring the world over (Turner et al., 2004; McKinney, 2002; Schei, 1996; Rapoport, 1991). Land-use changes, the resultant of increasing human population, has been recognized as one of the major drivers of future changes in biodiversity (Sala et al., 2000). Biodiversity

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has so wide meaning and consists of genetic diversity up to ecosystems diversity. Species diversity is known equal to biodiversity that is limited to diversity in local or regional surface (Krebs, 1998). Species diversity is one of the important specifications of bio-societies that are measured in different ways (Krebs, 1998). Diversity of organisms, measurement of diversity and examination of some hypothesis about reasons of diversity are some cases that have been favored by ecologists for a long time (Barnes et al., 1998).

Soil is an essential component that has sustained life on this planet, favoring the growth of plants that have survived human competition. The soil resource is limited in space and the soil evolution is a slow process. The chemical and physical properties of soils are controlled largely by clay and humus as they act as the center of activity around which reactions and nutrient exchange occurs (Buckman and Brady, 1967). Soil is a medium of all plant productivity. The vegetation in turn influences the physical and chemical properties of soil to a great extent. It improves the soil structure, infiltration rate and water holding capacity. Kashmir Himalaya, due to its rich repository of vegetation has attracted naturalists and botanists for more than two centuries (Dar et al., 2001). Numerous studies dealing with diverse aspects of vegetation from different areas of the region have been carried out from time to time (Dar et al., 2001; Stewart, 1982). The valley of Kashmir provides home to a large number of plant and animal species (Dar et al., 2002; Singh and Kachroo, 1983; Naqshi et al., 1976; Lambert, 1933). However, the general vegetation of Dachigam has been dealt with in detail by Singh and Kachroo (1976). They have recognized a number of vegetational types based on habitat, form and density of dominant species, though the vegetation patterns are controlled by such factors as habitat, slope, exposure to sunlight and altitude besides biotic factors.

The herbaceous layer composition is changing continuously in space and time due to multiple factors such as grazing, fire, soil properties and rainfall which differs in intensity and duration. The present study was conducted to assess the comparative variation in edaphic factors and herbaceous community features in terms of diversity, equability index and species richness in two different ecosystems in lower Dachigam National Park.

MATERIALS AND METHODS

Study area

Dachigam National Park is located between 34° 04′ -34° 14′ N latitudes and 74° 48′ to 75° 85′ E longitudes. The park is located nearly about 20 km away from Srinagar city of Kashmir valley with an undulating mountain valley topographic system. The area of the park is divided into two sectors: upper and lower Dachigam both are spread over an area of 141 km^2. The present study was confined to the lower Dachigam National park and it was conducted on seasonal basis at two different ecosystems (Site I, forest area located inside the official boundary of the Park) and (Site II, pastureland falls within the catchment of Dachigam but located outside the official boundary of the Park).

Soil analysis

Composite soil samples (0 to 30 cm depth) were collected using a soil auger on both selected sites. The collected samples were homogenized by hand mixing and sieved through a 2 mm mesh to remove large fresh plant material (roots and shoots) and pebbles. Finally, the samples were air dried for further analysis (Jackson, 1967). The samples were analyzed for determination of soil temperature (Gliessman, 2000), moisture content (Michael, 1984), organic carbon (Walkey and Black's rapid titration method: (Walkey and Black, 1934)) and total nitrogen by Kjeldahl method (Piper, 1966). pH was assessed by a digital pH meter (model Delux-101E) after a mixture with distilled water following this ratio 1:2.5 soil: water.

Vegetation analysis

To study the community composition and other phytosociological characteristics of the herbaceous vegetation at two selected sites, systematic field surveys were conducted during the four seasons spring (March to May), Summer (June to August), Autumn (September to November) and Winter (December to February). Phytosociological attributes of plant species were studied by randomly laying 25 quadrats of 1 ×1 m^2 at each site (Rajvanshi et al., 1987; Sharma et al., 1983). Specimens of each plant species were collected per site and were identified at Centre of Plant Taxonomy University of Kashmir/Botany Division, Forest Research Institute Dehradun, Uttarakhand.

Data analysis

The vegetational data was quantitatively analyzed for density, frequency and abundance according to the methodology described by Curtis and McIntosh (1950). Relative values of these parameters were calculated following Phillips (1959) and were summed up to get importance value index (IVI) (Curtis, 1959). The diversity index (H') was computed by using Shannon-Wiener index (Shanon-Weiner, 1963). Concentration of dominance was calculated following the formula given by Simpson (1949). Evenness index was computed according to Pielou (1966) whereas species richness was calculated according to Margalef (1958). Similarity index (IS) between any two sample sites or communities was derived from the formula given by Sorensen (1948).

RESULTS AND DISCUSSION

Soil characteristics

The physico-chemical attributes of soil are depicted in Figure 1. The results revealed maximum (25°C, summer) as well minimum (6°C, winter) soil temperatures obtained at Site II. Overall mean values of soil temperature also showed higher trend at Site II because of slope aspect receiving direct sunlight during early hours and also because of scanty vegetation cover. Generally high soil

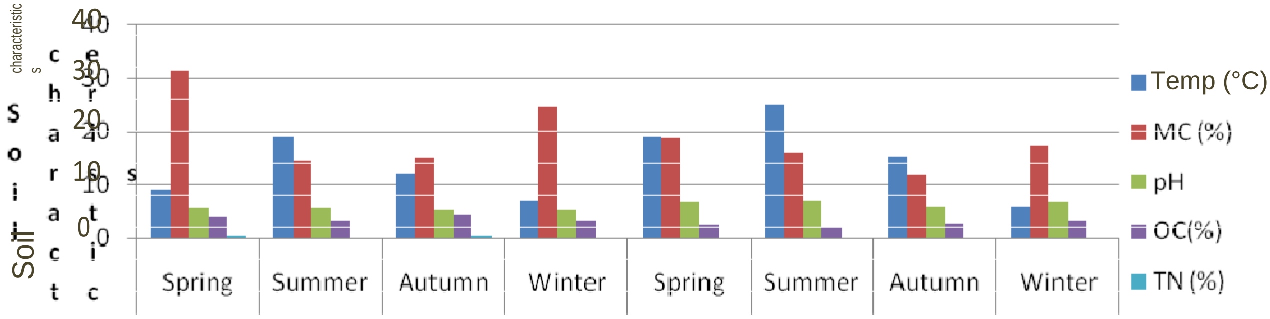

Figure 1. Seasonal variations in soil characteristics at two different sites.

temperature is recorded in areas where soil surface is not covered by vegetation have been observed by earlier workers (Kuhnelt, 1970). Vegetation removal can elevate nutrient availability (Davis and Pelsor, 2001), soil temperatures and correspondingly increase mineralization rates (Gurlevik et al., 2004). Soil moisture content ranged from 14.37 (summer) to 31.22% (spring) at Site I and 11.74 (autumn) to 18.68% (spring) at Site II. The general observation shows forest site ahead to pasture site in moisture content (Figure 1). Das et al. (1980) showed that the nature and content of organic debris returned to the forest floor varying with vegetation affecting the physical-chemical properties of the soil from the direct impact of raindrops, thereby controlling erosion on slopes and increases the moisture status of the soil. At Site II lowest percentage of moisture present in soil is mainly due to grazing as grazing and trampling by cattle increases the compactness of soils. The highly com-pacted soil in general shows a lower permeability and increased runoff (Saxena and Singh, 1984). Further due to inadequate vegetation cover and occurrence of denuded patches created as a result of over-grazing by domestic livestock, the direct sunlight received by soil surface at Site II enhances the chances of evaporation.

A reduction in soil moisture content due to grazing was also reported by (Branson et al., 1981). Soil pH influences the availability of plant nutrient and it is a good indicator of forest fertility (Black, 1968). pH values ranged from 5.41 (winter) at Site I to 6.91 (summer) at Site II. Overall highest pH was recorded in summer season at both sites (Site I, 5.79 and Site II, 6.91). Soil pH in Site I was overall acid and pH in such ranges (5 to 6) has already reported by Kharkwal and Rawat (2010). However, low pH at Site I may have been due to higher organic matter and continuous decomposition of surface litter over the years. Similar results pertaining to these observations were also reported by Raina (1988). Comparatively, lowest pH value was observed during dry season (autumn) compared to other seasons. Buckman and Brady (1967) and Keoghh and Maple (1972) have reported lower pH values during dry seasons. In general soils at both sites were mostly acidic in nature. The acidic nature of soil was also reported by (Kala, 2005) in grazed and un-grazed soils of western Himalaya. Soil organic matter is one of the most important soil component, along with stabilizing soil structure and improving infiltration rate. Organic carbon ranged from 3.21 (summer) to 4.33% (autumn) at Site I and 1.93 (summer) to 3.27% (winter) at Site II. Comparatively forest soil in general showed higher content of organic carbon (3.21 to 4.33%) Figure 1. It is due to higher amount of litter addition to the site and also because of tree cover. Similar observations in accordance to the present study were also reported by (Kharkwal and Rawat, 2010; Kharkwal et al., 2009; Kumar et al., 2002).

The closed canopy in natural forests also minimizes erosion resulting in accumulation of organic matter in natural forest compared to pastures. Besides, the difference in vegetation type, species composition and natural protection can be attributed to higher amount of carbon at Site I. The reason for lowest percentage of organic carbon at Site II is due to the grazing as grazing reduces soil organic matter, compacts the soil surface layer and ultimately increases surface runoff (Faizul et al., 1995). Like organic carbon total nitrogen content of soil revealed higher values for forest site (0.24%, summer to 0.33%, autumn) compared to pasture site (0.14%, summer to 0.24%, winter). However, during summer season total nitrogen was recorded lowest at both sites followed by a higher trend in autumn (Site I) and winter (Site II) Figure 1. The possible reason for higher organic matter and nitrogen content at Site I is due to thick forest vegetation, higher moisture content and low decom-position rate (Bortharkur, 1992). The higher amount of humus and total nitrogen percent in forest site could be explained by higher amount of available organic material at this site (Shourkaie et al., 2007). Similar seasonal variations in concurrence to the present study were also reported by several workers like Jenny (1930) and Jackman (1964). Sebastia (2004) showed that the soil fertility is the main environmental factor in vegetation establishment. Moreover, topography has indirect effect on plant community distribution. Because topography effects soil for example, slope, aspect and micro

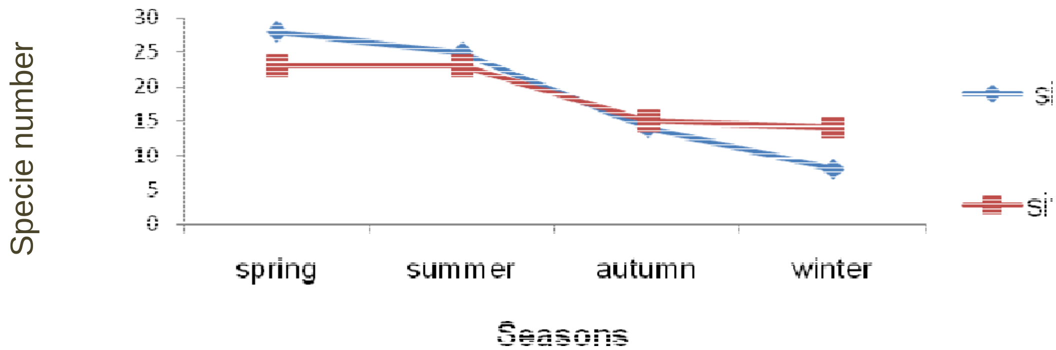

Figure 2. Species recorded during different seasons at two sites.

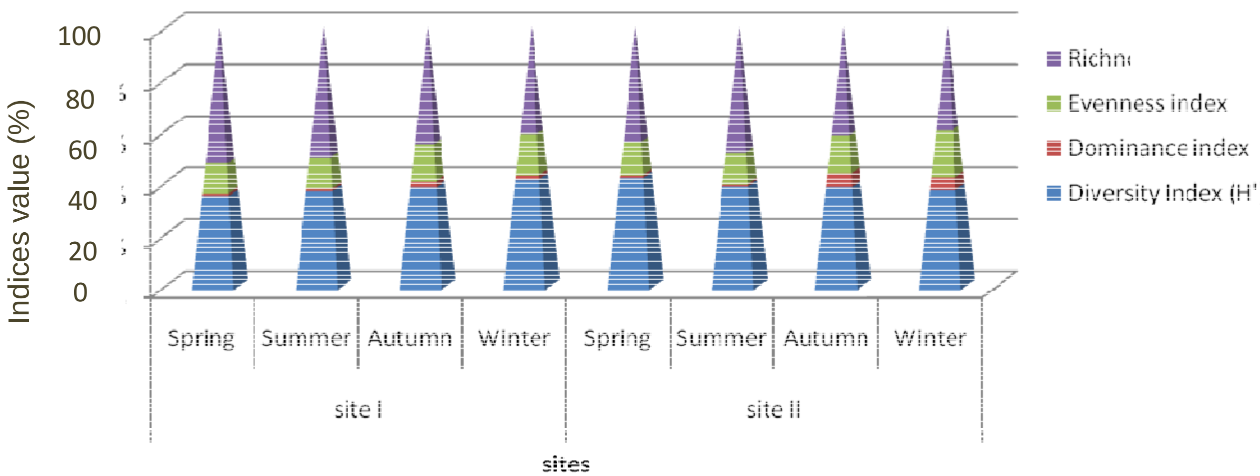

Figure 3. Diversity estimates of the vegetation at two study sites in four seasons using different diversity indices.

topography will affect soil drought and moisture (Heydari and Mahdavi, 2009).

Comparative values of total nitrogen at both sites revealed site I at higher side hence parallel to the findings of Lyaruu (2010).

Vegetation attributes

Species diversity

Species diversity is one of the most important characteristics of a community. It is a mechanism which generates stability. The nature of plant community at a place is determined by other species that grow and develop in such environment (Bliss, 1962). The general structure of species at both sites indicated increasing trend in their number mostly during spring and summer season (Site I, $_{Spring=23;Summer=23}$) and (Site II, $_{Spring=28;Summer=25}$). During autumn and winter season species number at both sites showed overall a declined trend (Site I, $_{autumn=15;\ winter=14}$) and (Site II, $_{autumn=14;\ winter=8}$) Figure 2. The maximum occurrence of species during spring and summer season could be due to availability of moisture provided mostly by rains and through other environmental factors. Similar pattern of observations mirrored to present study were also mentioned by Sharma and Upadhyay (2002). Alhassan et al. (2006) in their study reported similar factors responsible for the variation in species number and diversity. The species diversity in the present study ranged from 2.36 (autumn) to 2.92 (summer) at Site I to 1.80 (winter) to 3.03 (summer) at Site II (Figure 3). It becomes evident from the observations that diversity is moreover highest at protected site (Site I) than unprotected Site II (Sharma and Upadhyaya, 2002). Comparatively, results of Shannon diversity at both sites fall within the range of the study carried out by many authors (Lalfakawma et al., 2009; Yadav and Gupta, 2007; Kharkwal et al., 2004; Kiss et al., 2004).

Seasonal trend of diversity (H′) observed highest in summer season at both sites with Site II slightly at higher side (Site I, 2.92 and Site II, 3.03). This is in conformity with Moral (1972) and Zobel et al. (1976) who observed high diversity of herb layer in the absence of much vegetation cover. Badanon et al. (2005) attributed high species diversity at a site having high temperature due to slope aspect and less tree cover. Hence the findings are compatible with results achieved for Site II of the present study. The micro-environmental situation also affected the species diversity at Site I. However, during autumn and winter season diversity was lower which could be due to the lower rate of evolution and diversification of communities (Fisher, 1960; Simpson, 1964) and severity in the environment (Connell and Orias, 1964). An increasing trend in species diversity was observed from spring onwards which declined with the commencement of autumn and winter at both sites. This characteristic is attributed to the fact that during spring/ summer season new species go on sprouting depending upon the root/ seed stock in the soil and thereby adding to species in total resulted more diversity. During autumn and winter season the rate of sprouting of root/seed stock is diminished and species number declined owing to adverse climatic conditions (Shadangi and Nath, 2005).

The Simpson index is inversely related to the species diversity (H') at both sites in all micro-environmental situation (Figure 3). Such inverse relationship of diversity vs. dominance was also reported by Tripathi and Shukla (2007) and Kharkwal et al. (2004). Composition of the forest is diverse and varies from place to place because of varying topography such as plains, foothills and upper mountains (Singh, 2006). Among human influence, commercial exploitation, agricultural requirements, forest fire and grazing pressure are the important sources of disturbance (Singh and Singh, 1992). Plant diversity depicts higher trend in the national park with intermediate human influence (IHI) than other land use has been reported by Lyaruu (2010). The dynamics of vegetation in a rangeland are determined by array of factors which include fire frequency and intensity, grazing regime, climatic fluctuations and to some extent the soil characteristics. Moreover, the work on biodiversity indicated that diversity tend to be highest under moderate grazing intensity (Zhou et al., 2006). Research has shown that depending on the seasons, the density of grazers influences both species diversity, spatial heterogeneity and the vegetation structure (Metzger et al., 2005; Adler et al., 2001).

As estimated diversity (H′) reported highest during spring and summer season at Site II (2.92, spring and 3.03, summer) which might be due to moderate disturbance by grazing and invasion of new species. Connell (1978) and Decocq et al. (2004) also reported a highest diversity of species in intermediate disturbed ecosystem or when the grazing intensity is accelerated. Many other studies mentioned similar observations pertaining to the present study (Site II) emphasizing moderate level of grazing promoted species diversity (Rikhari et al., 1993; Singh et al., 2003). Expression of evenness value showed Site I at higher side (average = 0.915). The values of evenness supported by Lalfakawma et al. (2009) in conclusion that undisturbed site achieved highest equability than disturbed site. The lower values for species evenness index revealing distribution of individuals of the species in space at Site II (average = 0.852) which is probably due to patches of unpalatable species leftover by grazing animals after consuming the palatable ones. The growing dominance of non-palatable species and others in pastureland is probably an indication of adaption against herbivory and adverse climatic conditions.

Bhandari et al. (1999) made similar observation in pasturelands of Garhwal Himalaya. The evenness index reported by El-Khouly (2004) in a grazed site (1.25 and 0.91) and (0.99 and 0.78) in an ungrazed site were somehow comparable to the equability analyzed for Site I. Species richness which indicates both number of species and their numerical strength revealed slightly higher values for Site I (average = 3.297) compared to Site II (average = 2.652). This attributes increasing disturbances at Site II on account of grazing making micro-sites available for many opportunistic weed species. Based on frequency and density, 17 species at Site I and 14 at Site II showed high dominance (Figures 4 and 5). At Site I *Fragaria nubicola, Poa annua, Stipa sibirica, Trifolium pratense* and *Viola indica* frequently occurred during most of the season. However, *Taraxacum officinale* and *Tulipa stellata* were dominant in spring and *Arthraxon prinoides, Dioscorea deltoidea, Oxalis corniculata, Poa* sp., *Sorghum halepense* and *Trifolium repens* remained dominant in summer season. *Duchesnia indica* (autumn) and *Viola odorata* remained highly dominant during winter season.

Species depicted highest density at this site were *A. prinoides* (spring and summer), *F. nubicola* (spring and winter), *Hypericum perforatum* (spring), *P. annua* (spring and autumn), *Poa* sp. (summer), *P. steralis* and *V. indica* remained dominant during autumn season respectively. Fourteen highly dominant herbaceous species during different seasons at site II are depicted in Figure 5. It is evident from this figure that *Salvia moorcroftiana* and *Thymus serphyllum* were highly dominated and therefore, presented highest frequency and density during most of the seasons followed by *Cynodon dactylon, Origanum vulgare* and *Stipa sibirica* during spring and summer season respectively. *Bothriochloa pertusa* and *T. stellata* showed highest frequency in spring season. Frequently occurred species during summer season were *Carduus edlbergii, Erigeron canadensis, Lespedeza elegans, Oxalis corniculata, Plantageo lanceolata* and *T. officinale.* Highest density at this site was shown by *S. moorcroftiana* and *T. serphyllum* (spring to winter) followed by *C. dactylon* (spring to summer), *O.*

Figure 4. Seventeen highly dominant species based on frequency (%) and density/m^2 of Site I.

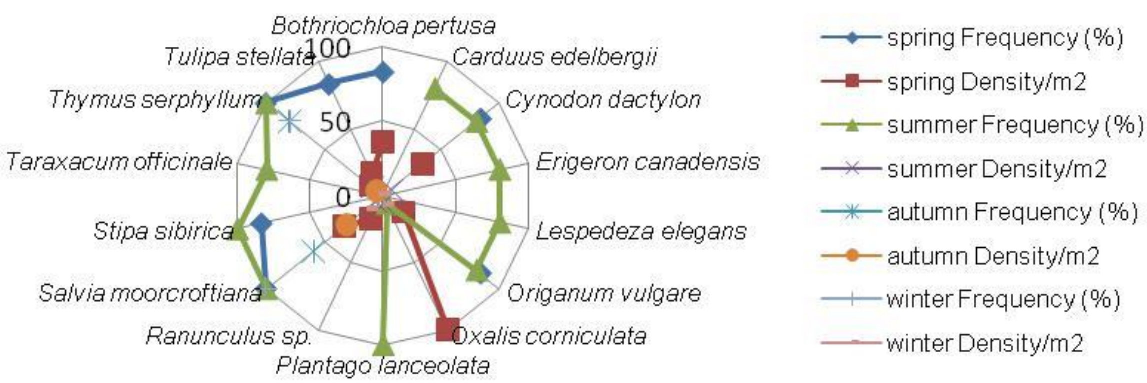

Figure 5. Fourteen highly dominant species based on frequency (%) and density/m^2 of Site II.

corniculata (summer), *P. lanceolata* (summer and winter) whereas *B. pertusa, Ranunculus* sp, *T. stellata* and *O. vulgare* showed highest density in spring season.

Frequency is a measure of the uniformity of the distribution of a species; thus a low frequency indicates that a species is either irregularly distributes or rare in a particular stand or forest. Frequent distribution of plant density, cover, biomass per unit area, and height, are used as a measures for expressing biological abundance and biological dominance of vegetation, have been used to describe species composition and spatial patterns of vegetation in different plant communities (Chen et al., 2008). Various parameters like topography, soil, climate, aspect, altitude and geographical location influence the vegetation diversity of forest. High frequency indicated more frequent distribution of species at the site due to optimum soil and environmental conditions. Species dominant during different seasons at Site I were *F. nubicola*, *P. annua*, *S. sibirica, T. pratens* and *V. indica* whereas *C. dactylon*, *O. vulgare*, *S. moorcroftiana* and *T. serphyllum* showed high dominance at Site II. Their dominance in a particular season is seen due to the availability of optimum conditions for their growth. Similar observations in context with the present study were also reported by Kukshal et al. (2009). However, maximum species showed dominance during spring and summer season at both sites, thus it becomes evident that during these seasons frequent occurrence of species is mainly due to the presence of suitable temperature, enough moisture and micro-nutrients (Nanette et al., 2007; Zaman, 1997; Skarpe, 1990). Difference in the species composition from site to site is mostly due to micro-environmental changes (Mishra et al., 1997).

Spatial variation might be due to the soil type and its composition, elevation of sites, moisture contents of soil, nature of disturbance like grazing pressure, human interference and isolation of study site populated regions (Alhassan et al., 2006). Maximum density at Site I was presented by *A. prinoides*, *F. nubicola*, *H. perforatum*, *P. annua*, *Poa* sp. *P. steralis* and *V. indica*. *B. pertusa*, *C. dactylon, O. vulagre*, *O. corniculata*, *P. lanceolata, Ranunculus* sp, *S. moorcroftiana*, *T. serphyllum* and *T. stellata* showed highest density at Site II (Figures 5 and 6). In general, density of herbaceous species varied at both sites. These changes are attributed to changes in microclimate among other factors. Similar changes were also reported by Ilorkar and Kharti (2003). Studies conducted by Abdullah at al. (2009) mentioned climatic factors as a reason to influence the distribution of species in certain habitats. Moreover, high dominance by any individual species indicated that most of the available resource are being utilized by that species and left over are being trapped by another species as the competitors and the associates. Further it can be hypothesized that distribution of niche space or availability of resource was equally distributed among all species that showed maximum dominance at both sites during a particular season. The overall high frequency and density recorded for both sites indicated that ecological dominance of species are commonly (wide niche) throughout the study period.

Comparatively, *T. officinale*, *O. corniculata*, *S. sibirica* and *T. stellata* commonly showed maximum importance at both sites. However, it can be correlated that the dominance of certain species at both sites during a particular period could be as the other co-dominant species do not reach maturity to complete their life cycle.

Similarity index

The two selected sites when compared on the basis of species similarity index where observed to show maximum similarity (15.22%) in spring and minimum (4.55%) in winter season. During spring season a high number of species occurred at both sites whereas a declined trend was observed when a winter season approached resulted less similarity among seasons and sites. Thus two sites depicted considerable dissimilarity in the herbaceous community structure which is related to differences in micro-climatic conditions and impacts favouring growth of different species at the two sites. A high degree of dissimilarity of herbs and grasses in such land uses has been reported before by Verma et al. (2005).

Conclusion

The present study indicates that Site I has a good fertility potential which may be due to less biotic and abiotic interferences and addition of a higher amount of leaf litter. High nutrient levels at Site I are also due to nutrient regeneration from fallen leaves, twigs, buds, flowers, decaying roots among other decaying material. Variation in quantitative parameters like, species richness and species diversity is related to variations in edaphic factors, elevation, slope aspect and micro-climatic conditions between the two sites. Seasons have great influence on soil properties and plant diversity. Amongst major factors that influenced vegetation structure are human disturbance, extensive grazing, trampling and soil erosion. We recommend implementation of a seasonal monitoring of soil characteristics and plant diversity in the two selected sites.

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REFERENCES

Abdullah MB, Sanusi SS, Abdul SD, Sawa FBJ (2009). An Assessment of the Herbaceous Species Vegetation of Yankari Game Reserve, Bauchi, Nigeria. Am-Eur. J. Agric. Environ. Sci., 6(1): 20-25.

Adler P, Raff D, Launeroth W (2001). The effect of grazing on the spatial heterogeneity of vegetation. Oecol., 128: 465-479.

Alhassan AB, Chiroma AM, Kundiri AM (2006). Properties and classification of soils of Kajimaram Oasis of Northeast Nigeria. Int. J. Agric. Biol*.,* 8: 256–261

Badanon EI, Cavieres LA, Molinga-Montenegro MA, Quiroz CL (2005). Slope and aspect influences plant association patterns in the Mediterranean mattoral of central Chile. J. Arid Environ., 62: 93-108.

Barnes BV, Zak DR, Denton SR, Spurr SH (1998). Forest Ecology. 4th Edn., John Wiley and Sons Inc., ISBN: 13: 978-0471308225, pp: 773.

Bhandari BS, Nautiyal DC, Gaur RD (1999). Strucutral attributes and productivity potential of an alpine pastures of Garhwal Himalaya. J. Ind. Bot. Soc., 78: 321-329.

Black CA (1968). Soil Plant Relations. J. Wiley and Sons. New York.

Bliss LC (1962). Rosine and lipid contents in alpine Tundra plants. Ecology, 43: 753-757.

Bortharkur DN (1992). Agriculture of Northern Eastern Region with Special Reference to Agriculture. BeeCee Prakashan, Guwahati.

Branson FA, Gifford GF,. Renard KG, Hadley RF (1981). Rangeland Hydrology (2nd Edn.). Society for Range Management Kendall/Hunt Publ. Co., Dubuque, IA Range Science Series. No. 1.

Buckman HO, Brady NC (1967). The nature and properties of soils. Eurasia Publishing House (Pvt) Ltd. New Delhi.

Chen J, Shiyomi M, Yamamura Y (2008). Frequency distribution models for spatial patterns of vegetation abundance. Ecol. Mod., 211: 403-410.

Connell JH (1978). Diversity in tropical forests and coral reefs. Sciences, 1999: 1302-1310.

Connell JH, Orias E (1964). The ecological regulation of species diversity. Am. Nat., 98: 399-414.

Curtis JT (1959). The vegetation of Wisconsin: An ordination of plant communities. University of Wisconsin Press, Madison, Wisconsin. 657 pp.

Curtis JT, McIntosh RP (1950). The interrelations of certain analytic and synthetic phytosociological characters. Ecol*.,* 31: 434-455.

Dar GH, Bhagat RC, Khan MA (2001). Biodiversity of Kashmir Himalaya. Valley Bok House, Srinagar, J & K, India.

Dar GH, Bhagat RC, Khan MA (2002). Biodiversity of the Kashmir Himalayas. Valley Book House, Srinagar, India.

Das SN, Maili TC, Banerjee SK (1980). Genesis of red and lateritic forest soils of west Bengal on Centenary basis, Part-I, Morphological studies. Ind. For., 106(10): 704-714.

Davis MA, Peslor M (2001). Experimental support for a resource-based mechanistic model of invasibility. Ecol. Lett., 4: 421-428.

Decocq G, Aubert M, Dupont F, Alard D, Saguez R, Wattez-Franger A, Foucault B. DE, Delelis-Dusollier A, Bardat J (2004). Plant diversity in a managed temperate deciduous forest: understorey response to two silvicultural systems. J. Appl. Ecol., 41: 1065-1079.

El-Khouly, AAL (2004). Effects of human activities on vegetation diversity in Siwa Qasis.International; Conf. On Water Resources & Arid Environment.

Faizul B, Karlw DM, Murray L (1995). Livestock grazing impacts on infiltration rates in a temperate range of Pakistan. J. Range Manage. 46: 367-372.

Fisher AG (1960). Latitudinal variation in organic diversity. Evolution, 14: 64-81.

Gliessman SR (2000). Field and laboratory investigation in Agro Ecology (Eric W . Engles, ed.) Lewis Pub. New York.

Gurlevik N, Kelting DL, Allen HL (2004). Nitrogen mineralization following vegetation control and fertilization in a 14-year-old loblolly pine plantation. Soil Sc. Soc. of Am. J., 68: 272-281.

Heydari M, Mahdavi A (2009). Patterns of plant species diversity related to physiographic factors in Melah Gavan protected area, Iran. Asian J. Biol. Sci., 2 (1): 21-28.

Ilorkar VM, Khatri PK (2003). Phytosociological Study of Navegaon National Park, Maharashtra. Ind. For., 129 (3): 377-387.

Jackman RH (1964). Accumulation of organic matter in some New Zealand soils under permanent pasture I. Patterns of change of organic carbon, nitrogen, sulphure and phosphorus. NZ. J. Agri. Res., 7: 445-471.

Jackson ML (1967). Soil chemical analysis. Asia Publication House, Bombay. p. 498 .

Jenny H (1930). A study on the influence of climate upon nitrogen and organic matter content of soil Missouri. Agri. Expt. Stat. Res. Bull., p.152 .

Kala CP, (2005). Community composition, species diversity, and secondary succession in grazed and ungrazed alpine meadows of the West Himalaya, India. Int. J. Fiel. Std., 2(1).

Keoghh JL, Maples R (1972). Variation in soil test results as affected by seasonal sampling. Bulletin, Arkansas Agricultural Experiment Station. No. 777, p. 26. Arkansas University, Fayetteville, USA, 123: 715-783.

Kharkwal G, Rawat YS (2010). Structure and composition of vegetation in subtropical forests of Kumaun Himalaya. Afr. J. Plant. Sci., 4(4): 116-121.

Kharwal GP, Rawat YSM, Pangtey YPS (2004). Comparative study of herb layer diversity in pine forest stands at different altitudes of central Himalaya. Appl. Ecol. and Environ. Res., 2(2): 15-24.

Kharkwal G, Rawat YS, Pangtey YS (2009). An ordination of the forest communities in Nainital catchment of Kumaun Himalaya. J. Env. Biol., 30 (5): 853-857.

Kiss T, Sipos G, Bodis K, Barta K (2004). Community composition, species diversity, and secondary succession in grazed and ungrazed alpine meadows of the west Himalaya, India. Int. J. Fld.wrk. Stud., 2(1). Cite page Number.

Krebs JC (1998). Ecological Methodology. Addison Wesley Longman Inc., ISBN: 13: 978- 0321021731, pp. 620.

Kuhnelt W (1970). Structural aspects of soil surface-dwelling biocoenosis in methods of study in soil ecology. Proc. Paris Symp. p.46 .

Kukshal S, Nautiyal BP, Anthwal A, Sharma A, Bhat AB (2009). Phytosociological investigation and life form pattern of grazing lands under pine canopy in temperate zone, Northwest Himalaya, India. Res. J. Bot., 4: 55-69.

Kumar S, Sharma JC, Sharma IP (2002). Water retention characteristics and erodibility indices of some soils under different land uses in northwestern Himalayas. Ind. J. Soil Cons., 30(1): 29-35.

Lalfakawma, Sahoo UK, Roy S, Vanlalhriatpuia K, Vanalalhluna PC (2009). Community Composition and Tree Population Structure in undisturbed and Disturbed Tropical Semi-Evergreen Forest Stands of North-East India. Appl. Ecol. and Environ. Res., 7(4): 303-318.

Lambert WJ. (1933). List of trees and shrubs for Jammu and Kashmir Forest Circles. Bot. Ser. For. Bull., No. 80.

Lyaruu HV (2010). The influence of soil characteristics on plant species diversify and distribution patterns in Western Serengeti, Tanzania, 5(3): 234-241.

Margalef R (1958). Perspectives in ecological theory. University of Chicago Press, Chicago.

McKinney ML (2002). Urbanization, biodiversity, and conservation. Bio.Sci., 52: 883-890.

Metzger KL, Coughenour MB, Reich RM, Boone RB (2005). Effects of seasonal grazing on plant species diversity and vegetation structure in semi-arid ecosystem. J. Ari. Environ., 61: 147-160.

Michael P (1984). Ecological methods for field and laboratory investigations. Tata Mcgraw Hill Pub. Comp. Ltd.

Mishra D, Mishra TK, Banerjee SK (1997). Comparative phytosociological and soil physic-chemical aspects between managed and unmanaged lateritic land. Ann. For., 5(1):16-25.

Moral RD (1972). Diversity patterns in forest vegetation of Wenatchee Mountain, Washington. Bull. Torr. Bot. Clu., 99: 57-64.

Nanette M, Deacon L, Robinson C (2007). Greater nitrogen and/or phosphorus availability increase plant species' cover and diversity at a high arctic polar semi-desert. Polar Biol. 30: 559–570

Naqshi AR, Javeid GN (1976). Two new plant records for India. J. Bombay Nat. Hist. Soc., 74(2): 393-394.

Phillips EA (1959). Methods of vegetation study. Henry Holt and CO., New York. p. 318.

Pielou EC (1966). Species diversity and pattern diversity in the study of ecological succession. J. Theor. Biol., 10: 370-383.

Piper CS (1966). Soil and Plant Analysis. Hans Publisher, Bombay. Raina JN (1988). Physico-chemical properties and available macro-nutrient status of citrus growing soils of Poanta valley in Himachal Pradesh. Him. J. Agri. Res., 2: 71-78

Rajvanshi R, Kumar V, Bachpari W, Rajgopal K, Raj SFH (1987). Herbaceous under growth in some forest habitats in Nilgiris. Ind. For. 113(9): 599-608.

Rapoport EH (1991). Tropical versus temperate weeds: A glance into the present and future. pp. 441-451. In: P.S. Ramakrishnan (ed.). Ecology of Biological Invasion in the Tropics. International Scientific Publications, New Delhi.

Rikhari HC, Negi GCS, Ram J, Singh SP (1993). Human-induced secondary succession in alpine meadow of Central Himalaya, India. Art. and Alp. Res., 25: 8-14.

Sala OE, Chapin III FS, Armesto JJ, Berlow E, Bloomfield J, Dirzo R, Huber-sanwald E, Hunneke LP, Jackson RB, Kinzig A, Leemans R, Lodge DM, Mooney HA, Oesterheld M, Poff NL, Sykes MT, Walker BH, Wall DH (2000). Global biodiversity scenario for the year 2100. Sc., 287: 1770-1774.

Saxena AK, Singh JS (1984). Tree population structure of certain Himalayan forest associations and implications concerning their future composition. Veget., 58: 61-69.

Schei PJ (1996). Conclusions and recommendations from the UN/ Norway Conference on alien species. Sci. Int. 63:32.

Sebastia MT (2004). Role of topography and soils in grassland structuring at the landscape and community scales, Basic Appl. Ecol., 5: 331–346.

Shadangi DK, Nath V (2005). Impact of seasons on ground flora under plantation and natural forest in Amarkantak. Ind. For., 131(2). 240-250.

Shannon CE, Weiner W (1963). The Mathematical Theory of Communication. University Illinois Press, Urbana.

Sharma SK, Georga M and Prasad KG (1983). Forest vegetation survey and classification with special reference to South India. 1. Vegetation survey and quadrate analysis. Ind. For., 109 (6): 384-394.

Sharma KP, Upadhyaya BP (2002). Phytosociology, primary production and nutrient tetention in herbaceous vegetation of the forestry arboretum on the Aravalli hills at Jaipur. Trop. Eco., pp. 325-335.

Skarpe C (1990). Structure of the woody vegetation in disturbed and undisturbed arid Savanna, Botswana. Plant Ecol., 87: 11–18

Shourkaie SG, Chaichi MR, Saravi MM, Hosseini HMS, Lotfollahi M (2007). Evaluation of grazing intensity effects on organic matter content and mineral nutrients recycling in rangeland soils (Case study: Mirza Bailue Rangelands, Golestoan Province, Iran).

American-Eurasian J. Agric. Environ. Sci., 2 (5): 504-510. Simpson EH (1949). Measurement of diversity. Nature. 163: 688-699. Simpson, GG (1964). Species diversity of North American recent mammals. Syst. Zool., 13: 57-73.

Singh JB, Kachroo P (1983). Exotic trees and shrubs of Kashmir. Ind For., 109: 60-76.

Singh YP, Kumar A, Rai JPN (2003). Species diversity as related to grazing pressure in alpine meadows of Nanda Devi Biosphere Reserve. Pro. Nat. Seminar on Biodiversity conservation and management, EPCO, Bhopal. pp. 147-153.

Singh G, Kachroo P (1976). Forest Flora of Srinagar and Plants of Neighbourhood. B. Singh and M.P. Singh, Dehradun.

Singh JS, Singh SP (1992). Forest of Himalaya, Structure, Functioning and impact of Man. Gyanodaya Prakashan, Naintal, India.

Singh JS (2006). Sustainable development of Indian Himalayan region: Linking ecological and economic concerns. Curr. Sci., 90(6): 784-788.

Sorensen T (1948). A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. Detkong Dansk Vidensk. Selsk. Biol. Skr., 5: 1-34.

Stewart RR (1982). History and exploration of plants in Pakistan and adjoining Areas (Nasir, E. and S.I. Ali, eds.) Pan Graphics, Islamabad, Pakistan.

Tripathi S, Shukla RP (2007). Effect of clipping and grazing on various vegetational parameters of grassland communities of Gorakhpur, U.P. Trop. Ecol., 48 (1):61-70.

Turner WR, Nakamura T, Dinetti M (2004). Global urbanization and separation of humans from nature. Bio. Sci., 54: 585-590.

Verma RK, Kapoor KS, Rawat RS, Subramani SP, Kumar S (2005). Analysis of plant diversity in degraded and plantation forests in Kunihar forest division of Himachal Pradesh. Ind. J. For., 28(1): 11-16.

Walkey AE, Black JA (1934). An examination of the Degtiga vett. method for determining soil organic matter and proposed modification of the chromic acid titration method. Soil Sci., 37: 29.

World Commission on Environment and Development (WCED). (1987). Our Common Future. University of Oxford, England.

Yadav AS, Gupta SK (2007). Effect of micro-environment and human disturbance on the diversity of herbaceous species in Sariska Tiger Project. Trop. Ecol., 48(1): 125-128.

Zaman S (1997). Effects of rainfall and grazing on vegetation yield and cover of two arid rangelands in Kuwait. Environ. Conserv., 24: 344–350

Zhou H, Tang X. Y, Zhao X. Zhou LI (2006). Long-term grazing alters species composition and biomass of a shrub meadow on the Qinghai-Tibet Plateau. Pak. J. Bot., 38(4): 1055-1069.

Zobel DB, McKee BA, Hawk GM, Dryness CT (1976). Relationships of environment to composition, structure and diversity of forest communities of the central western cascades of Oregon. Ecol. Monog., 46: 135-156.