# Effect of Human Activities, and Environmental Changes on an Alpine Vegetation of District Chamoli, Garhwal Himalaya, Uttarakhand, India

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**Abstact:** District Chamoli is famous for its high peaks and several alpine meadows. The world famous 'Valley of Flowers' and 'Rudranath Bugyal' are the centre of great tourist attraction on account of their scenic grandeur and the wealth of beautiful flowers. Human activities such as tourism and biotic pressure (grazing, etc.) have tremendously increased during last two decades that has a profound effect on the ecology of valley and adjoining area result a change on the vegetation composition of this beautiful alpine pasture of Rudranath (Garhwal Himalaya). To observed the changes, the valley has undergone growth form pattern and phytosociological attributes were analysed during 2002 under grazed and highly disturbed (exposed to extension grazing) and ungrazed or undisturbed (protected from grazing) conditions. These observations were repeated during 2007. It was observed that number of early growing species and long vegetative growth cycle species had increased at both sites in 2007 in comparison to 2002. The less palatable species viz., *Anemone* spp., *Poa annua*, *Polygonum* spp., *Ranunculus hirtellus*, etc., predominantly found near the timber line at sub alpine region, were present at both sites with higher dominance (TBC) and niche width in 2007 indicating wide distribution of the species along an altitudinal gradient. These observations indicated the migration of these species towards upper slopes of alpine. Species diversity was also higher after five years. However, it is obvious that climatic changes alone are not responsible for these vegetational shifts. Infect, human induced changes are the main reasons for habitat destruction and changes in vegetation composition of the alpine region of Garhwal Himalaya. Before final conclusions can be made, long –term studies in vegetation composition and changes are needed, especially in Himalayan region.

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## 1. Introduction

In Himalaya, fluctuations in snowfall cause rapid recession of glaciers- presumably a natural phenomenon. However, the current human – induced changes are the major reason why glaciers are reducing (Naithani *et al*., 2001). Impact on alpine ecosystem in generally predicted in terms of variation in vegetation composition and invasion of species from lower altitude. The ultimate concern is, therefore, stability of alpine soil as it is determined by vegetation cover (Korner, 1999). Rudranath is one of the famous religious shrines of Hindus where large herds of sheep, goat and buffalo reach every year during May- October for summer grazing. Nearly 4000 -5000 sheep / goat, 50- 70 buffalo and 30 – 40 horses and mules reach in the alpine pastures of Rudranath and thus heavy grazing pressure. Grazing of prime factors in maintaining the status of alpine grazing land and attempts have been made already to document changes in plant population structure, productivity and carrying capacity (Ram *et al*., 1989; Sundriyal and Joshi, 1990; Sundriyal 1994, 1995; Nautiyal et al., 1997 a b). However, information is still lacking especially on (1) impact of long term grazing on vegetation composition and diversity, and (2) effect of changing climate especially on alpine vegetation. The aim of this paper is to assess the impact of biotic pressures grazing along with environmental changes governing vegetation composition and ground cover of an alpine zone.

The exploitation of several plants for aesthetic medicine and fragrances, exorbitant grazing pressure in alpine region of Garhwal Himalaya have led to drastic changes in vegetation composition and population of species during last few decades. This has further enhanced by the climatic changes of alpine regions as global temperature has increased up to $0.06^0$C over the past century, and it is predicted to rise a further 1.5- 4.5 $^0$C by 2100 AD (Houghton *et al*., 1996). The alpines are among the sensitive ecosystem that respond easily against any changes in climatic and other biotic activities.

### 1.1 Objective of the study

The broad objective of the study is to assess human impact on alpine regions (1) to determine the temperature of five year intervals (2) to estimated the vegetation in this regions (3) to analyze the determinants on the vegetation change

### 1.2 Study sites

The present study was conducted in an alpine zone of Rudranath (3200-3600 m $30^0$28'N and $79^0$ 20' E) in district Chamoli and west of Garhwal Himalaya

The topography of the area is completely hilly with gradual slopes forming alpine scrub and alpine meadow. Below 3000m there is a steep gradient towards North – East and North – West aspects of the area. The climate is harsh with low temperature and partial pressures of gases, blizzards and hailstorms prevail year around except for a few months. Snowfall generally occurs from November to April; however, the intensity of deposition, rate of snowfall and duration of snow cover varies from year to year. The climatic data collected during 2005 and 2010 are represented fig.1. Maximum air temperature recorded were $24.0^0$C in 2005 and $24.5^0$C in 2010. However, a range of minimum temperature and soil temperature remained the same during the past decade. The alpine region of Rudranath is under the direct control of forest department and the people of lower valley have the right to use the region for summer grazing. The diverse topography, narrow landscape and land owner ship restricted the investigations except for a small area. Thus two sites were selected having similar topography i.e south west facing with moderate slopes ($37$ -$43^0$) at the elevation of 3600 m. The plot area for both sites was marked as 50X50 m in 2005. One site was fenced by barbed wire to present from grazing and other anthropogenic activities. The other site was nearby and exposed to grazing (grazed site). Vegetational changes and impact of grazing on community structure were assessed.

## 2. Methodology

The study was undertaken to visualize the vegetational changes in grazed and controlled conditions during 2005 and was repeated in 2010 on the same sites. Data were collected for floristic composition and population density for each species at one month intervals w.e.f May to October. For quantitative analysis, the quadrat method was adopted (Kershaw, 1973). Twenty five quadrats of 1 X 1 m size were laid randomly in each site during 2005 and marked with iron wire (0.1cm diameter). Quantitative analysis on these quadrats was repeated during 2010. Each species found in sampling plots was examined for frequency, density and basal cover respectively by observing presence or absences, number of individuals of each species and measuring mean diameter of individuals of species found in each quadrat at both plots (grazed and ungrazed) following the procedure of Curtis and McIntosh (1950) and Mishra (1968). Percent presence of dominant species was calculated to find the changes in species occurrence. Similarly, niche width was calculated for important species by the method of Levins (1968) using the equation.

$ßi = \sum (Nj)/\sum N^2j$

Where j is density value (plant $m^{-2}$) in selected stands. In our study, instead of using important values of species in different stands (Sai and Budholiya, 1986), we use important value of each species during different month to find adoptability and utilization of resources by these species under grazed and uncontrolled condition.

## 3 Results

### 3.1 *Variation in growth forms, species growth cycle and species composition*

Observations on growth form, growth cycle and growth initiation patterns of the grazed and ungrazed plots for the present study are described here. Six major classes of growth forms, i.e. grasses, sedges, tall, medium and small, forbs and scrubs were identified at both demonstrated sites. One species of grass was observed in disturbed site in 2005 while 3 grass and 2 sedge species were seen in 2010. In contract the fenced site was found to have 2 grass and 1 sedge species initially and after 5 years the number increased to 3 grass and sedge species each. This is an indication of invasion of more unpalatable species in a short spam of five years owing to biotic pressure as well as change in the alpine environment. No tall forbs were found during 2005 but there were 3 tall forbs in the grazed site in 2010. Numbers of medium forbs was also higher at both sites viz., 9 in the grazed and 18 in the ungrazed sites. However, number of short forbs in 2010 was low in the ungrazed sites and higher in the grazed sites as compared to 2005. Variation in growth form during 2005 and 2010 in the grazed site on the basis of ANOVA was found to be significant ($F=4.6$, $P < 0.5$, df -5) and maximum variability of 12.5 percent was detected for medium forbs. In ungrazed sites there was 32 percent variation in the numbers for medium forbs and this variation was found statistically significant ($F= 5.25$, $P<0.05$, df- 5).

In general the percentage of early growing and late growth cycled species was higher during 2007. In the ungrazed site, 11 species were early growing and 12 were long cycled during 2002. Long growth cycle species made the major contribution along with intermediate growth cycle species during 2007. The analysis of variance for growth initiation categories indicated that there were 40 and 24 percent variability in the numbers of long growth cycled plants (F=1.76, P< 0.5, df-2). However, variation was in significant for growth categories during 2005 and 2010. Maximum numbers of species were found during August at both sites and years. It was interesting to note that with increasing species at both sites, the number of early growing as well as long growth cycled species also increased during 2007.

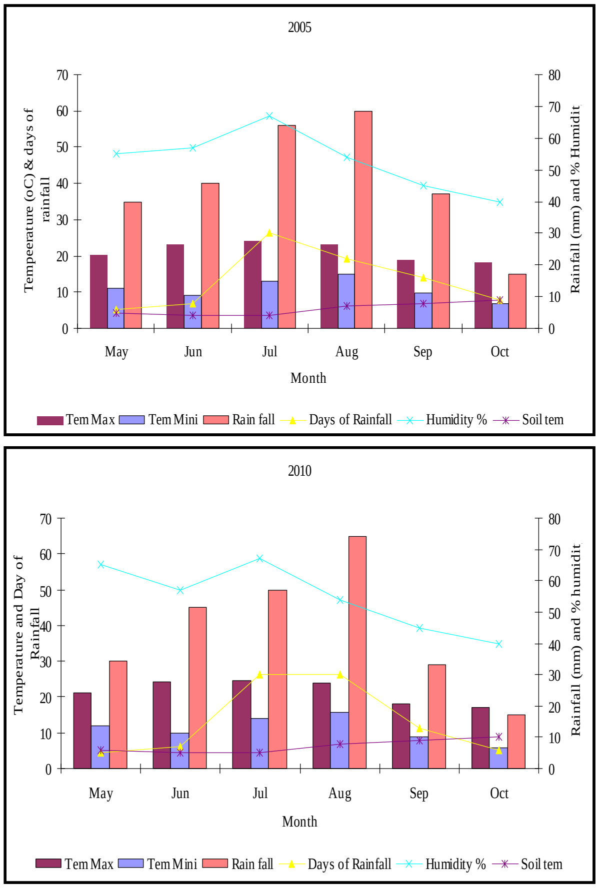


Fig. 1. Climatic data of Rudarnath alpine zone during 2005 and 2010.

### 3.2 *Variation in plant density and relative dominance*

*Danthonia jacqmontii* showed maximum density during 2005 and in the ungrazed site during 2010. *Poa annua* was the dominant species with a density value of 890.67 tillers $m^{-2}$ in grazed sites during 2010. In ungrazed sites, *Carex alpine* (568.09 tillers $m^{-2}$) emerged as co- dominant species during 2010, replacing *Agrostis munroana.* Similarly in the grazed site *Bupleurum himalaylayenc* and *Polygonum verticellatum* replaced co dominant species *Anaphalis royleana* of during 2005. It is interesting that species number as well as species density was higher during 2010. In addition, there was variation in species density during different month and maximum variation was observed in June and indication of increasing in early growth species. Comparatively, only 9, 10 and 11 species contributed to density during 2002 in June, August and October, respectively, while 24, 23 and 19 species were found contributing to density in the grazed site. Similarly, 16, 17 and 18 species contributing during 2002 and number of species increased to 18, 25 and 25 during those some month in 2010 in the ungrazed site. Our observations indicate that early growing species in the grazed site and late growing species in the ungrazed site were more abundant.

Total Basal Cover (TBC) was computed to observe the comparative variation in species dominance. During 2005, at the grazed site *Danthonia jacqmontii* was dominant species with total basal cover of 1.01 $cm^2$ $m\text{-}^2$. This species was replaced by *Impatiens gigantea* (1.94 $cm^2$ $m\text{-}^2$) followed by *Poa annua*, *Anemone rivularis*, *Potentilla atrosanguinea* and *Ranunculus hirtellus* during 2007 as co- dominant species. On the basis of Important Value Index (IVI), an index which represents the over all ecological success of a species in community, *Denthonia jacqmontii* (80.78) was dominant species during 2005, but was replaced by *Poa annua* as a dominant species with the IVI value of 48.90 at the grazed site during 2010. However, *Denthonia jacqmontii* remained dominant at the ungrazed site from 2005 to 2010.

Among the different compartment of vegetation in alpine, i.e grasses, sedges and herbs, grasses contributed maximum density as well as basal cover initially at the time of sprouting. These were followed by herbs during 2010 percent contribution of sedges to density and basal cover was higher than in 2005. Overall increase in community density at the grazed site was nearly 2.5-3.5 times greater during 2010. However, relative dominance at the ungrazed site was much lower during 2010 than during 2005.

### 3.3*Variation in percent presence and niche appearance*

*Danthonia jacqmontii*, *Potentilla atrosanguinea* and *Taraxacum officinale* had 100% presence in both 2005 and 2010 (Table 2). However, other *Polygonum* spp., *Potentilla cuneata*, *Impatiens gigantea* and *Jurinea macrocephala* had increased percent presence as well as niche appearance during 2007. Four species of *Polygonum* had niche value between 2.90 and 2.98 during 2010 at the grazed site (Table 1). While at the ungrazed site, the niche values fluctuate between 1.38 and 2.99 in the same year.

Table 1. Percent presence (%P) and Niche width (ßi) of some dominant species

| Species | Disturbed site | | | | Undisturbed site | | | |
|---|---|---|---|---|---|---|---|---|
| | 2005 | | 2010 | | 2005 | | 2010 | |
| | %P | ßi | %P | ßi | %P | ßi | %P | ßi |
| **Grasses** | | | | | | | | |
| *Agrostis munroana* | * | * | 55.65 | 1.57 | 45.55 | 1.0 | 78.09 | 1.98 |
| *Danthonia jacqmontii* | 70 | 2.45 | 100 | 1.50 | 100 | 2.90 | 100 | 2.12 |
| *Poa annua* | * | * | 100 | 1.54 | * | * | 80 | 1.97 |
| **Sedges** | | | | | | | | |
| *Carex alpine* | * | * | * | * | 66.66 | 1.89 | 66.66 | 1.70 |
| *Carex nubicola* | * | * | 66.67 | 1.90 | * | * | 100 | 1.67 |
| *Kobressia nepalensis* | * | * | 100 | 1.99 | * | * | 100 | 2.86 |
| **Herbs** | | | | | | | | |
| *Anaphalis triplinervis* | 77.78 | 1.09 | 77.68 | 1.00 | 78.70 | 2.89 | 78.70 | 2.00 |
| *Androsace lanuginosa* | 55.89 | 2.04 | 55.68 | 2.00 | 75.55 | 1.0 | 78.56 | 2.95 |
| *Anemone rivularis* | * | * | * | * | 66.66 | 2.86 | 66.66 | 2.0 |
| *Brachypodium sylvaticum* | 45.55 | 1.0 | 40.55 | 1.95 | 45.55 | 1.0 | 66.66 | 2.99 |
| *Bupleurum himalayense* | 66.66 | 2.86 | 100 | 1.27 | 100 | 2.95 | 100 | 2.95 |
| *Calamogrostis emodensis* | * | * | * | * | 100 | 2.90 | 89.90 | 1.90 |
| *Corydalis cornuta* | * | * | 33.33 | 1.0 | * | * | 33.33 | 1.0 |
| *Dactylorhiza hatazaria* | 33.33 | 1.37 | * | * | 33.33 | 1.68 | 33.33 | 1.39 |
| *Delphinium denudatum* | 33.33 | 1.12 | 33.33 | 1.29 | 33.33 | 1.16 | 33.33 | 1.33 |
| *Gaultheria nummularioides* | * | * | 100 | 1.79 | * | * | 45.50 | 1.00 |
| *Geranium wallichianum* | * | * | * | * | 75.00 | 1.57 | 80.00 | 1.90 |
| *Geum elatum* | 89.00 | 1.98 | 67.88 | 1.76 | 100 | 2.44 | 66.66 | 1.0 |
| *Gypsophila cerastioides* | 66.66 | 1.94 | 66.66 | 1.77 | * | * | 100 | 1.62 |
| *Habenaria marginata* | * | * | 55.55 | 1.88 | * | * | 55.55 | 1.75 |
| *Impatiens gigantean* | * | * | 66.66 | 1.71 | 100 | 2.44 | 66.66 | 1.0 |
| *Inula grandiflora* | * | * | * | * | 33.33 | 1.78 | 33.33 | 1.98 |
| *Juncus himalensis* | * | * | 66.66 | 1.96 | 100 | 3.36 | 100 | 2.88 |
| *Nardostachys jatamansi* | * | * | * | * | 33.33 | 1.98 | * | * |
| *Pedicularis hoffmeisteri* | 100 | 2.15 | 66.66 | 1.88 | * | * | 66.66 | 1.98 |
| *Picrorhiza kurrooa* | 66.66 | 1.94 | 66.66 | 1.93 | * | * | 66.66 | 1.79 |
| *Plantago major* | * | * | 33.33 | 1.67 | * | * | 33.33 | 1.34 |
| *Polygonatum verticellatum* | * | * | * | * | 33.33 | 1.57 | 33.33 | 1.78 |
| *Polygonum amplexicaule* | * | * | 100 | 2.90 | 100 | 2.91 | 100 | 2.98 |
| *Polygonum nepalensis* | 100 | 2.48 | 100 | 1.34 | 100 | 2.53 | 100 | 2.70 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Potentilla atrosanguinea* | 100 | 2.29 | 100 | 2.90 | 100 | 2.91 | 100 | 2.66 |
| *Potentilla fulgese* | * | * | 45.55 | 1.78 | 33.33 | 1.00 | 33.33 | 1.00 |
| *Saxifraga diversifolia* | * | * | * | * | 100 | 2.65 | 66.66 | 1.0 |
| *Scrophularia calycina* | * | * | 33.33 | 1.56 | 33.33 | 1.34 | 33.33 | 1.67 |
| *Stachys sericea* | * | * | * | * | 33.33 | 1.56 | 33.33 | 1.45 |
| *Stellaria semivestita* | 100 | 2.56 | 66.66 | 1.98 | 100 | 2.76 | 100 | 2.78 |
| *Swertia cuneata* | * | * | 33.33 | 1.56 | 66.66 | 1.77 | 66.66 | 1.56 |
| *Tanacetum longifolium* | * | * | 66.66 | 1.0 | 66.66 | 1.0 | 66.66 | 1.0 |
| *Trifolium repens* | 100 | 2.86 | 100 | 2.93 | 100 | 2.97 | 100 | 2.33 |
| *Veronica cana* | * | * | * | * | 33.33 | 1.67 | 33.33 | 1.56 |
| *Viola biflora* | 100 | 2.98 | 33.33 | 2.25 | * | * | 100 | 1.21 |

Table 2. Variation in Species density and dominance pattern at the grazed and ungrazed site at Rudarnath.

| | **Density (Plants $m^{-2}$)** | | | | **TBC ($Cm^2$ $m^{-2}$)** | | | | **IVI** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Disturbed** | | **Undisturbed** | | **Disturbed** | | **Undisturbed** | | **Disturbed** | | **Undisturbed** | |
| | **2005** | **2010** | **2005** | **2010** | **2005** | **2010** | **2005** | **2010** | **2005** | **2010** | **2005** | **2010** |
| **Grasses** | | | | | | | | | | | | |
| *Agrostis munroana* | * | 132.1 | 145.12 | 157.2 | * | 0.05 | 0.76 | 0.057 | * | 11.01 | 8.09 | 11.98 |
| *Danthonia jacqmonhii* | 332.70 | 332.45 | 353.6 | 361.50 | 1.01 | 0.90 | 1.0 | 0.91 | 80.78 | 42.90 | 40.67 | 52.12 |
| *Poa annua* | * | 890.67 | * | 131.54 | * | 0.45 | * | 0.065 | * | 48.90 | * | 5.97 |
| **Sedges** | | | | | | | | | | | | |
| *Carex alpine* | * | * | 476.67 | 568.09 | * | * | 0.09 | 0.78 | * | * | 5.66 | 31.70 |
| *Carex nubicola* | * | 336.68 | * | 451.90 | * | 0.06 | * | 0.89 | * | 11.98 | * | 6.67 |
| *Kobressia nepalensis* | * | 14.23 | * | 41.99 | * | 0.07 | * | 0.97 | * | 1.74 | * | 5.86 |
| **Herbs** | | | | | | | | | | | | |
| *Anaphalis triplinervis* | 27.08 | 11.00 | 7.68 | 21.00 | 0.99 | 0.70 | 0.09 | 0.89 | 8.79 | 2.89 | 18.70 | 6.00 |
| *Androsace lanuginosa* | 55.09 | 42.04 | 55.68 | 42.00 | 0.08 | 0.99 | 0.06 | .98 | 5.55 | 3.0 | 8.56 | 2.97 |
| *Anemone rivularis* | * | * | 17.59 | 11.2 | * | * | 0.45 | 0.15 | * | * | 6.56 | 5.20 |
| *Brachypodium sylvaticum* | 45.55 | 51.0 | 40.55 | 51.95 | 0.08 | 0.09 | 0.34 | 0.50 | 15.55 | 11.0 | 5.66 | 2.99 |
| *Bupleurum himaylanse* | 26.66 | 32.86 | 28.26 | 11.27 | 0.12 | 0.34 | 0.07 | 0.13 | 6.95 | 6.92 | 2.34 | 1.95 |
| *Calamogrostis emodensis* | * | * | 23.41 | 45.42 | * | * | 0.07 | 0.08 | * | * | 9.90 | 2.90 |
| *Corydalis cornuta* | * | 44.30 | * | 41.0 | * | 1.01 | * | 1.01 | * | 27.98 | * | 1.0 |
| *Dactylorhiza hatazaria* | 23.30 | * | 30.65 | 34.57 | 1.20 | * | 0.99 | 0.98 | 13.31 | * | 3.33 | 1.39 |
| *Delphinium denudatum* | 43.33 | 41.12 | 43.33 | 41.29 | 0.09 | 0.62 | 0.60 | 0.8 | 11.33 | 11.16 | 7.10 | 3.33 |
| *Gaultheria nummularioides* | * | 21.86 | * | 18.66 | * | 0.14 | * | 0.62 | * | 7.89 | * | 5.86 |
| *Geranium wallichianum* | * | * | 78.98 | 9.06 | * | * | 0.68 | 0.11 | * | * | 7.83 | 3.06 |
| *Geum elatum* | 29.00 | 13.98 | 47.88 | 31.76 | 1.00 | 0.56 | 1.09 | 0.08 | 44.7 | 6.44 | 16.66 | 8.0 |
| *Gypsophila cerastioides* | 26.66 | 19.40 | * | 21.77 | 0.89 | 0.67 | * | 0.67 | 23.07 | 11.39 | * | 5.62 |
| *Habenaria marginata* | * | * | 35.55 | 31.88 | * | * | 1.02 | 1.09 | * | * | 15.55 | 11.75 |
| *Impatiens gigantean* | * | 9.06 | 36.76 | 31.71 | * | 1.94 | 0.45 | 0.44 | * | 4.44 | 5.66 | 8.0 |
| *Inula grandiflora* | * | * | 21.80 | 19.86 | * | * | 0.76 | 0.40 | * | * | 6.33 | 3.08 |
| *Juncus himalensis* | * | 3.73 | 22.93 | 8.96 | * | 0.22 | 1.31 | 0.20 | * | 3.21 | 8.02 | 3.88 |
| *Nardostachys jatamansi* | * | * | 18.56 | 212.34 | * | * | 1.04 | 1.77 | * | * | 2.54 | 1.30 |
| *Pedicularis hoffmeisteri* | 39.73 | 39.6 | * | 3.73 | 0.30 | 0.17 | * | 0.63 | 19.58 | 3.73 | * | 2.98 |
| *Picrorhiza kurrooa* | 22.90 | 26.94 | * | 31.93 | 0.98 | 0.99 | * | 0.76 | 14.65 | 4.5 | * | 1.56 |
| *Plantago major* | * | 11.98 | 15.89 | 12.67 | * | 0.56 | 0.29 | 0.90 | * | 19.00 | 9.09 | 3.34 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Polygonatum vertceillatum* | * | * | 21.33 | 41.78 | * | * | 0.90 | 0.98 | 2.4 | 1.50 | 3.39 | 9.78 |
| *Polygonum amplexicaule* | * | 12.8 | 41.06 | 7.40 | * | 0.04 | 1.72 | 0.2 | * | 27.91 | 6.70 | 8.38 |
| *Polygonum nepalensis* | 36.53 | 29.86 | 116.6 | 16.54 | 0.51 | 0.27 | 3.22 | 0.25 | 27.63 | 7.70 | 23.32 | 8.35 |
| *Potentilla atrosanguinea* | 43.98 | 27.29 | 130.80 | 22.90 | 0.422 | 0.46 | 1.29 | 0.56 | 18.92 | 10.0 | 15.85 | 9.43 |
| *Potentilla fulgens* | * | 18.76 | 35.55 | 23.78 | * | 1.59 | 2.89 | 2.07 | * | 11.05 | 13.33 | 11.00 |
| *Saxifraga diversifolia* | * | * | 36.8 | 14.4 | * | * | 0.38 | 0.09 | 18.09 | 2.65 | 16.63 | 1.05 |
| *Scrophularia calyciana* | * | 6.4 | 31.46 | 1.06 | * | 1.09 | 0.09 | 0.90 | * | 9.34 | 3.38 | 7.67 |
| *Stachys sericea* | * | * | 45.89 | 34.86 | * | * | 0.55 | 0.99 | * | * | 27.83 | 21.45 |
| *Stellaria semivestita* | 57.90 | 42.56 | 52.44 | 31.98 | 0.99 | 0.65 | 0.98 | 0.95 | 23.23 | 12.76 | 12.98 | 12.00 |
| *Swertia cuneata* | * | 4.8 | 12.34 | 5.56 | * | 0.99 | 1.08 | 1.0 | 13.80 | 7.77 | 11.32 | 5.57 |
| *Tanacetum longifolium* | * | 5.76 | 6.67 | 17.0 | * | 1.00 | 0.91 | 0.76 | 5.90 | 4.6 | 6.66 | 2.33 |
| *Trifolium repens* | 65.90 | 66.88 | 54.46 | 52.93 | 0.09 | 0.07 | 0.23 | 0.08 | 3.90 | 2.97 | 13.00 | 11.03 |
| *Veronica cana* | * | * | 34.38 | 55.23 | * | * | 0.09 | 0.78 | 3.23 | 1.60 | 5.30 | 3.56 |
| *Viola biflora* | 23.45 | 22.98 | * | 12.25 | 0.09 | 0.89 | 0.09 | * | 2.90 | 11.0 | * | 11.21 |

## 4. Conclusion and Discussion

Species composition has changed markedly as a result of opportunistic replacement of sort – lived species by long – lived species. In general, Semwal (1982) has recorded 176 species from this alpine site and nearly 171 species were studied by Nautiyal *et al* (2001) for growth cycle and growth form. Out of these 84% species had intermediate growth cycle followed by long and short growth cycle. Further 47% were identified as early growing species and 53% were late growing species. However, our observation recorded that after five years the numbers of early growing species in the grazed site and long cycled species in both sites have increased. Biotic influences and disturbances are much more severe and immediate on these ecosystem. These conditions create opportunities for the establishment of new individuals through canopy opening (Cullen *et al.*, 2001). In the prolonged absence of grazing (as in the present ungrazed site), short lived plants such as *Oxygraphis* and *Taraxacum officinale* expanded initially during the onset of favorable conditions, senescing and subsequently replaced by tussock grasses and long vegetative growth cycled plants and subsequently both sites had maximum species diversity.

It was observed in 2010 that dominant and co- dominant species at both sites were either non palatable (*Danthonia jacqmontii Anemone rivularis, Ranunculaus hirtellus*) or had mostly distributed at timber line or sub alpine species; *Poa alpine, Anemone rivularis* with wide distribution range and thus showed their upward migration. There were variation in species wise dominance during early and late growing seasons with rather low variation during August, the month of peak growing season where several species are at the peak of their growth and bloom, and hence contributed more or less to community cover both at the grazed and ungrazed sites.

With increasing species number, density and relative dominance, community density as well as cover were also higher during 2010. The increase in species number and density resulted from invasion of some early growing species as most of alpine species have some short of clonal, rather slow mode of propagation as well as slow seedling establishment after long winter dormancy and thus provide space to upward migration. These invading species are mainly tall and intermediate herbs having well developed (woody) stem and occupy more space than existing alpine vegetation and hence increased vegetation cover.

In grazing sites, species composition is altered by selective grazing of taller forbs, short and palatable grasses. Intensity of grazing and exploitation also determine the vegetation composition and structure. McIntyre and Lavorel (2001) reported that high level of grazing was associated with annual grasses, low growing leafy perennials (mostly grasses and sedges) and mat forming herbs like *Trachydium roylei.* Although annual grasses in alpine are very rare but with mat forming herbs (*Poa annua- Trachydium roylei*) formed the dominant vegetation composition in meadows with higher grazing intensity. In general grazing encourages the clonal growth of perennial grasses (Nautiyal *et al.*,1997). However, the intensity of grazing effects the balance between several and vegetative spread of plants and establishment of its seedlings (Bullock *et al.,* 1994). As grazing intensity increase the growth of the dominant grasses or forbs is suppressed and gaps are open in the field (Watt and Gibson, 1988). On moist meadows in alpine region of Garhwal, we found that these gaps are occupied by invasion of new species take place, which increase the diversity. Studies on pastures from where grazers have been excluded have shown that initially the perennial grasses and long vegetative growth cycled plant increases resulting in rapid decline in species diversity. (Hill *et al.,* 1992).

The expansion of *Polygonum* species over past 5 year appears near the heaps of dung that accumulate from large herd of sheep, goat and buffalo. At such places these species are found to regenerate rapidly through underground perennating organs and have wide range of adaptability. Ecological process and selective grazing of plants have interacted to produce changes in species composition, some transitory and some permanent (Wahren *et al.,*1994). Long lived plants such as *Polygonum* species have continued to expand and there was no evidence that grazing reduced total cover of grasses and these forbs in alpine grazing lands.

Beside these biotic influences, climatic changes can also contribute to change in species composition and dominance diversity pattern. Pauette (1988) reported that general succession is controlled by climate. Introduction and establishment of these migrating species at Rudranath alpine region from lower altitude was observed as maximum temperature increased up to $2^0$C with little snow gall and early snow melt ( Naithani *et al.,*2001),. The climatic conditions that favour early initiation of plants and increased the length o growing season, favour long growth cycled plants. Korner (1999) stated that rising temperature and longer season alone or in combination reduce some dominant alpine plant life.

Lessening environmental limitation opens alpine terrain for invaders from lower elevation and creates pressure for upward migration of alpine species. Reports in invasion of sub alpine meadows and recent establishment of woody vegetation above the current tree line (Kullman, 1990; Rochefort *et al.*, 1994) and shrub invasion of arid grassland in North America (Van Auken 2000) suggested that invasion was the result of increased temperature.

With changing climate and increasing biotic stress, a species, ability to utilize natural resources and to maintain its population in different environment also change. Species with wider niches are considered to be more generalized and are able to manage a wide range of resources but those with narrower niche are more specialistic (Smith 1980). Specialistic species are equipped to exploit only a narrow set of specific resources. Species viz., *Jurinea macrocephala*, *Potentilla atrosanguinea* and *Anaphalis* spp., had wider niche appearance and indicated wide range of adaptability and resources utilization capabilities as they are non- palatable, morphological adapted to harsh alpine condition with rapid multiplication means.

As stated above species composition and density pattern has changed in both sites because of grazing and other anthropogenic activities. However, impact of climatic changes can not be ignored when considering that the ungrazed site has also shown increased diversity and density. In general, changes individual species, taxon and geographical region may have a number of possible explanations. In particular, switches in biotic trend are uniquely predicted as a response to climatic change (Parmesan and Yohe, 2003). Increased the alpine Himalaya can include changes in vegetational composition during early and long season growth along or in combination especially in alpine of subtropical region were impact of global warming are more severe. Before minimizing the confounding factors, searching for trends in undisturbed area and testing for significant associations with climate change is required (Nautiyal *et al.,* 2004). Our finding are of primary level and suggest monitoring of climatic changes and their impact on vegetational composition and soil stability in alpine of Himalaya should be made at regular basis before final conclusion.

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