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AN ASSESSMENT OF PHYTOSOCIOLOGICAL DIVERSITY OF KUTHER WATERSHED, HIMACHAL PRADESH, INDIA

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Abstract

A plant community acquires many characteristics which are not found in its constituents, (organisms or population). A community is described through species diversity, life forms, structure, dominance and developmental status. To delineate these aspects two significant parameters like analytical characters (quantitative - frequency, density, abundance and cover; qualitative - physiognomy, phenology, sociability, vitality and life form) and synthetic characters (constancy, fidelity and dominance) were studied. The present study focuses on species composition, phytosociological diversity and concentration of dominance of various tree species of Kuther watershed of Himachal Pradesh, India.

Keywords: Phytosociological Diversity, Analytical Characters, Synthetic Feature, Kuther Watershed of Himachal Pradesh, India.

Introduction

Phytosociological Diversity is part of our daily lives, livelihood, and constitutes resources upon which the humanity depends. It influenced by the biotic and a biotic factor. India is one of the world's top 17 mega-diversity countries, which possess 60-70% of the World's biodiversity (http://www.environment.gov.au/node/21579). India's biological richness and related indigenous knowledge is well recognized. The Indian sub-continent is well known for its diverse bioclimatic regions supporting vast flora and fauna. India's strategies for conservation and sustainable utilization of biodiversity in the past were mainly focused at providing special states and protection to biologically rich areas by declaring them as national parks, wildlife sanctuaries, biosphere reserves and ecologically fragile and sensitive areas (Sahu, S.C. et.al, 2007). Having witnessed the extinction of several hundred species in the twentieth century, the Biological Diversity Act 2002 enacted by the Indian Parliament is a significant attempt to make progress and to operationalize the important provisions of the Convention on Biological Diversity. We know that ecosystems are undergoing change due to pollution, invasive species, overexploitation by humans, and climatic change. The Indian efforts to conserve its precious biological diversity aim to promote conservation, sustainable use and equitable sharing benefits of it biological richness. Ecosystem diversity has not been even reasonably explored yet (Menon, A.R.R. 2005). Hence, there seems to be a wide gap of knowledge at global, regional and local levels.

The vast biodiversity of earth's forests provide the human race trees for timber, fuel, food, industrial raw materials (fiber, pulp, oil, dyes, rubber), pharmaceuticals (enzymes, drugs), beverages (tea, coffee, cocoa), and environmental stabilization. Forests provide a habitat for wildlife. In recent years, international concern over the uncontrolled destruction of natural forests has resulted in the global realization that such reserves are finite and are being progressively destroyed without consideration of the potential consequences involved (Jenkins, M. 2003).

European ecologists developed systems of description and classification and this aspect of ecology is known as phytosociology. The present study aims to document the phytosociological diversity to understand the ecological status of Kuther watershed, Himachal Pradesh, India. Plant and animal communities are indicators of the environment. They respond not only to one environmental factor but also to an interacting group of factors.

These communities influence and react sensitively to change in the balance of environmental stresses. Vegetation ecology includes the investigation of species composition and sociological interaction of species in communities. It is useful to collect such data to describe the population dynamics of each species studied and how they relate to the other species in the same community (Reddy, S. et.al, 2008).

This research paper is dealing with the floristic diversity and phytosociology study of Kuther watershed. The number of species occurring at site is grouped seasonally, i.e. pre-monsoon, monsoon and post-monsoon. The species were further recorded for the study of phytosociology.

Study area

This research has been carried out in the tract of Kuther watershed, Himachal Pradesh, India. The geographic location is latitude N 76^{o} 20' 0" and N 76^{o} 52' 30" and longitude E 32^{o} 11' 0" and E 32^{o} 36' 0". The total geographical area is 1797.28 Km^{2}. It is divided into three Forest Ranges, viz; Bharmour, Sawai and Trehta. The tract is traversed along its length by two main Himalayan ranges namely the Mid-Himalayan or Pangi Range and the Outer Himalayan or Dalhousie Range. Pangi range forms the northern boundary separating it from the district Lahaul and maintains its lofty heights and runs in a south-west to north-west direction. The Dhauladhar ranges by maintaining its lofty height goes up to Dharamshala in Kangra District where it loses its magnanimity rather abruptly and then near Banikhet in Chamba District. It suddenly dwarfs down to 1500 m. Only the northern slopes of this range, forms the part of Bharmour Forest Division and are wooded. The study area has been shown in Fig I. and field photograph in Fig II.

FOREST TYPE

This paper classified the forest type based on Champion and Seth (1968), the forests of the study area fall under the following types:

Type 12/C1a:Ban oak forests

When well developed, the trees from a closed canopy about 20 m high (up to 25 m). More usually they form a somewhat open forest of rather short boled and low branchy trees though often of considerable girth and on southern aspects the cover may be decidedly incomplete.

Type 12/C1b: Moru Oak Forest

With the damper climate and sites affected, and a warm summer despite a pronounced cold winter, this type is definitely more luxuriant than the ban oak, and forms in fact some of the finest moist temperate broadleaved forests. The height is typically 20 to over 30 m but can attain 44 m.

Type 12/C1c: Moist Deodar Forest

The forest is perhaps typically nearly pure deodar but more or less blue pine and a little spruce are commonly present. Most of the forests seen appear to have been considerably influenced directly or indirectly by human activities and so are not in truly climax condition. The canopy is typically fairly complete but not very dense (except locally in young crops) and the boles are straight and tall; a height of 30-40 m is usual.

Type 12/C1d: Western Coniferous Forest

These forests are the most attractive in the Himalayas with a varying mixture of coniferous trees often of very fine growth, spruce, silver fir, blue pine and deodar, and a varying inter-mixture of evergreen and deciduous broadleaved trees and strips and patches of broadleaved forests. A height of 50 m is by no means uncommon among the conifers and trees of very large girth are frequently met with.

Type 12/C1e: Moist Temperate Deciduous Forest

A deciduous high forest, 20-30 m high, the trees running to large girths though usually rather branchy, and the species occurring mixed singly or by groups of varying extent.

Type 12/1s1: Alder Forest

Typically nearly pure forest 20-30 m high as a strip of varying width along stream sides, spreading out to larger areas on landslips and screes; more or less deciduous.

Type 12/2s1: Low Level Blue Pine Forest

These forests from the nature of their origin are typically more or less even aged with blue pine pure or strongly predominating.

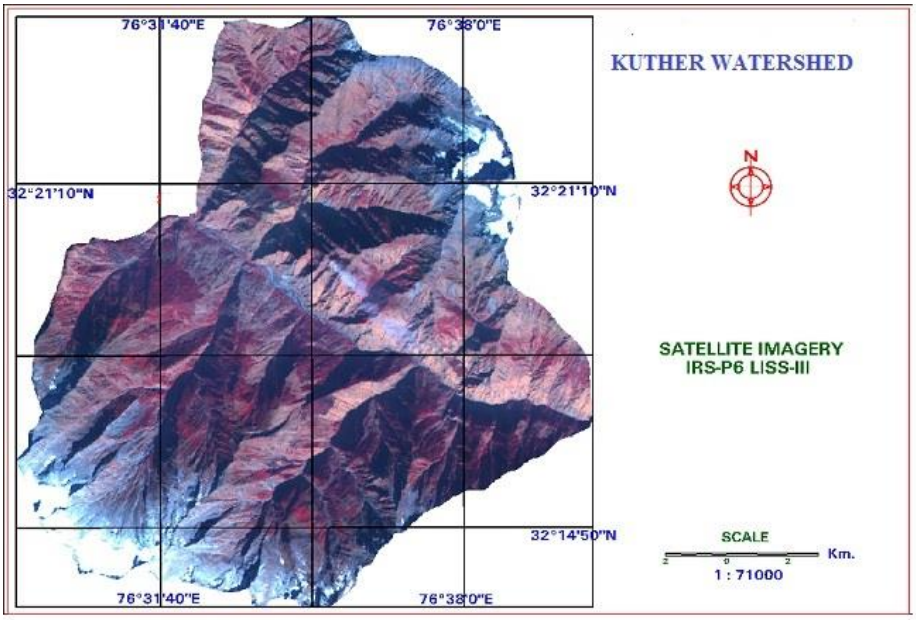

Fig I: Study Area of Kuther watershed

Fig II: Field Photograph of of Kuther watershed

FLORA OF KUTHER WATERSHED

The commonly occurring floral species in the Kuther watershed are *Alnusnitida, Quercusilex*, *Cedrusdeodara, Juglansregia, Morusserrata,Celtisaustralis, Populusciliata* and *Rhododendron arboreum* etc. *Alnusnitida* is found growing along the streams along the river while *Quercus ilex* and *Cedrusdeodara* found growing on the drier slopes.

CLIMATE

The climate of Kuther watershed is affected by the tropical weather systems during summer and the cold weather systems known as Western Disturbances during winter and per-monsoon months.

Winter	: December to March
Summer/pre-monsoon	: April to May
Monsoon	: June to September
Post-monsoon/Autumn	: October to November

The average rainfall of the Kuther watershed is 1370 mm. Generally humidity is above 80% during the south-west monsoon season. In the post monsoon and winter seasons the humidity is comparatively less. Summer is the driest season of the year.

Methodology

The present investigation is based on extensive field survey in selected forest types of Kuther watershed. The seasonal study has been conducted of herbaceous vegetation between May 2008 to November 2008, for three different seasons covering monsoon and post-monsoon season and pre-monsoon season.

LAND USE MAP

The Satellite data of IRS P6 LISS-III acquired from NRSC. It was processed in ERDAS Imagine Software. The standard False Colour Composite (FCC) was been generated by assigning blue, green and red colors to visible green, visible red and near infrared bands respectively. Expressing image pixel addresses in terms of a map coordinate base is often referred to as geo-coding. The 1:50,000 scale toposheets No 52 D/7, D/8, D/11 & D/12 of the study area were used for the purpose of geo-referencing. A large number of GCPs were selected for reasonably accurate geo-referencing. A map projection system (real world) was also defined.

Histogram of the scene under study has been generated to check the range of spectral values present in the scene. In order to use total grey range and to optimize the contract, the actual grey level ranges of three bands were linearly stretched independently. The zoomed images were studied wherever necessary. The interpretation key necessary for identifying different features has been developed systematically on the basis of image characteristics and

associated elements viz. shape, size, shadow, pattern, color/tone, texture, association, location and available ground truth. Among these characteristics, shape, size, shadow and pattern are basically dependent on the scale of the image whereas the color/tone and texture depends upon the brightness, contrast and resolution of the image (Lillesand, T.M. and Kiefer, R.W., 2006). Various land units were identified, delineated and the map was validated.

Prior to ground truthing, the satellite data was classified using unsupervised classification technique. Further, after collecting ground truth details maximum likelihood classification based supervised classification method was used with remote sensing image data. After the supervised classification procedure, a land use map was prepared which the team at field verified, and any errors or omissions were identified. A reclassification of the land-use categories implementing the details and corrections, if any, was done. The reclassification output was used for the preparation of the final land use classification map. Land use map play a prominent role in assessing phytosociological investigation. Land use map has been shown in Fig III.

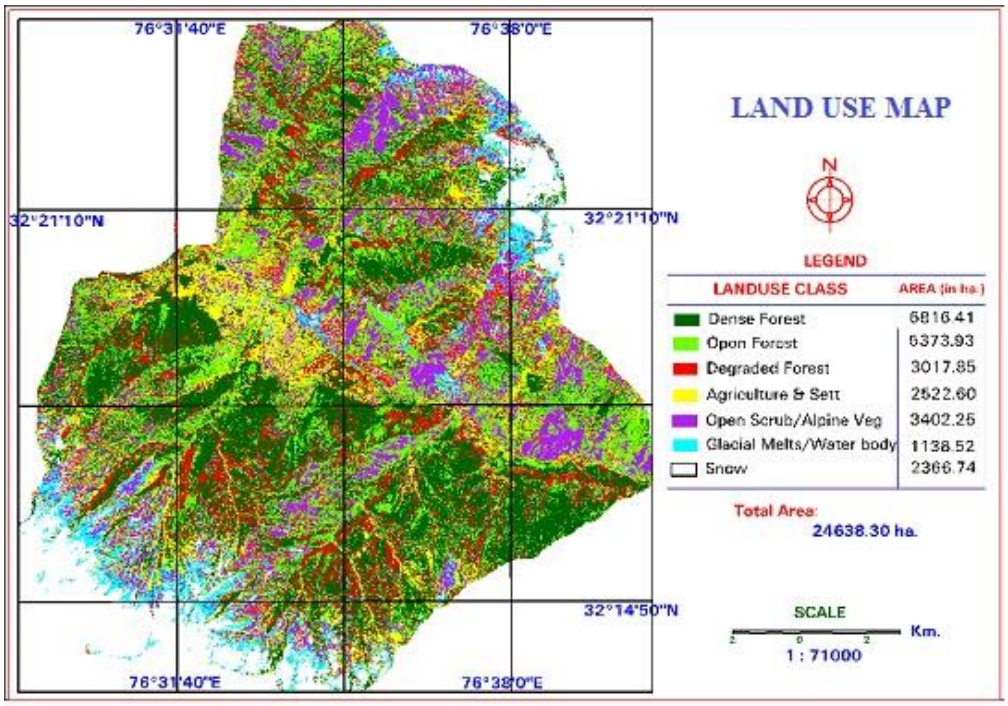

Fig III: Land Use Map of Kuther watershed

PHYTOSOCIOLOGY

A nested quadrats technique was used for sampling the vegetation. The size and number of quadrates needed were determined using the species area curve and the running mean method. The use of quadrates (10 x10 m) laid out for sampling the tree stratum and 1x1m quadrates for herbs, grasses and seedlings of tree species less than 1.3 cm dbh (diameter at breast height) at different altitudinal gradients using GPS (Leica GPS Model GS 20). However, for examining the shrub species 3x3m sample plots were laid out due to undulating terrain. The enumeration of vegetation in each of the quadrate was done by measuring dbh individually in case of woody vegetation and collar diameter in case of herbs and grasses, with the help of electronic digital caliper (Masser Excaliper II). In case of grasses and sedges, each erect shoot is considered to a plant tiller and the enumeration was done by laying 1x1m quadrates at random. Total number of sample plot is 10. Fig IV is illustrating the quadrat design of sampling.

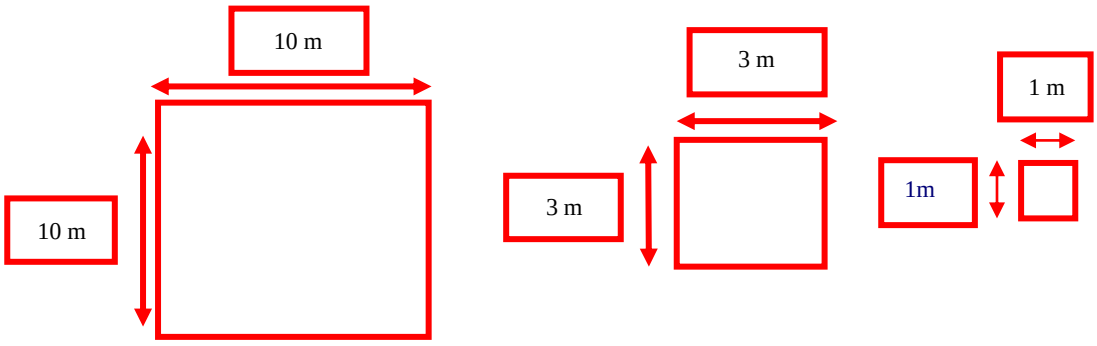

Fig IV: Quadrat Design for vegetation sampling

For any community study, the parameter such as frequency, density or cover alone bears its own significance. Individually however, these parameters are insufficient to provide a complete picture of ecological importance of a species. For instance, frequency gives an idea as to how a species is dispersed in the area but cannot tell about the number of individuals or the area covered. On other hand, density of a species gives the numerical strength of individuals, but cannot tell us whether these individuals are uniformly distributed or aggregated at a few places. Therefore, for a complete picture of ecological importance of a species, the percent values of relative frequency (RF), relative density (RD) and relative cover (RC) are added together and this value is called importance value index (IVI) of the species.

Different parameters for each species were calculated with the help of specific formulae to derive frequency, density, dominance, IVI etc. listed below (Singh, M. P. and Singh, E., 2010):

$$\textbf{Density} = \frac{\text{Total number of individuals of a species in all the quadrats}}{\text{Total number of quadrats studied}}$$

$$\textbf{Frequency (\%)} = \frac{\text{Total number of quadrats in which species occurred}}{\text{Total number of quadrats studied}} \times 100$$

$$\textbf{Abundance} = \frac{\text{Total number of individuals of a species in all quadrats}}{\text{Total number of quadrats in which species occurred}}$$

$$\textbf{Mean basal area} = \frac{C^2}{4\pi} \text{ (C= Mean of the circumference)}$$

Total basal area = Mean basal area × Density

$$\textbf{Mean of the circumference (C)} = \frac{\text{Sum of all cbh of a species}}{\text{Total number of individuals of a species}}$$

$$\textbf{Relative Density} = \frac{\text{The density of a species}}{\text{Total density of all species}} \times 100$$

$$\textbf{Relative Frequency} = \frac{\text{The frequency of a species}}{\text{Total frequency of all species}} \times 100$$

$$\textbf{Relative Dominance} = \frac{\text{Total basal cover of a species}}{\text{Total basal cover of all species}} \times 100$$

Importance Value Index (IVI) =Relative Density + Relative Frequency + Relative Dominance

TREE SPECIES DIVERSITY INDEX

The tree species diversity index for each stand in different forest types was determined using Shannon Wiener (1949) information function, which is:

$$H = -\sum_{i=1}^{s} (Ni/N) \ln (Ni/N)$$

Where, Ni is the total number of individuals of species i and N is the total number of all species in a stand.

Results and discussion

PHYTOSOCIOLOGICAL ANALYSIS

The vegetations of Kuther watershed were surveyed to assess the floral diversity in terms of trees, under storey vegetation (shrubs and saplings) and herbaceous/ground vegetation. The commonly occurring species are *Alnusnitida, Quercus ilex, Cedrusdeodara, Celtisautralis,Berberis lyceum, Prinsepiautilis, Valerianajatamansi, Pinuswallichiana, Plectranthusrugosus, Rubuslasiocarpus, Urticadioica, Daphne oleoides, Debreagasiahypoleuca* etc.

The dominant tree species found are *Alnusnitida* (210 trees/ha) followed by *Quercus ilex* (170 trees/ha). Among the species found, the IVI of *Alnusnitida* (92.89) was highest followed by *Quercus ilex* (56.17) and *Oleacuspidata* (29.42) (Annexure 1). The tree species diversity index (H') for the area is 2.02.

Among the 12 species of shrubs and saplings found at the barrage site area, *Berberis lyceum* (3056 plants/ha), *Plectranthusrugosus* (2389 plants/ha) and *Myrsineafricana* (2083 plants/ha) were recorded dominant. The IVI of *Berberis lyceum* (54.94) and *Prinsepiautilis* (40.46) was found maximum followed by *Cotoneaster acuminata, Debraegesiahypoleuca, Desmodiummicrophyllum* and *Rhamnusvirgatus*. Species diversity index (H' =2.34) (Annexure 1).

During the pre-monsoon period, 28 herbs were recorded. Valerianajatamansi (0.32 plants/ m^2), Loniceraquinquelocularis (0.28 plants/m^2) and Artemisia dracunculus (0.27 plants/m^2) was maximum. In terms of IVI, Loniceraquinquelocularis (75.9) showed the

highest followed by Artemisia dracunculus (22.6) and Valerianajatamansi (20.5) (Annexure 1). Species diversity index (H'= 2.87).

During the monsoon, 36 herb species were recorded, of which *Artemisia dracunculus* (0.67 plants/m^2) was recorded dominant in terms of density followed by *Solanumnigrum* (0.57 plants/m^2) (Annexure 1). However, *Loniceraquinquelocularis* (regeneration) assessed high IVI of 52.2 followed by *Artemisia dracunculus* (25.3). Species diversity index (H'=1.78).

During the post-monsoon period, 14 herbs were recorded from the dam site to the downstream area. In terms of density *Rumexhastatus*(1.33 plants/m^2) was recorded dominant followed by *Cynodondactylon* (0.73 plants/m^2). However, *Origanumvulgare* (71.43) and (39.83) showed highest (Annexure 1). Species diversity index (H'=1.459).

The assessment of Phytosociology of Kuther watershed, Himachal Pradesh, India poses a formidable task for the botanists and ecologists. The methodology adopted in the present study presents a means for rapid assessment of phytosociological study combining features of remote sensing, and ground inventory. The satellite imagery is amenable to various scales depending upon the survey needs and is the natural choice for this type of jobs. The impact of scale on the level of information, as shown by this study, is considerable. Hence, scale should be given due consideration before implementing this type of tasks. It is expected that the present methodology will help in rapid inventory for phytosociology of the plant communities.

Conclusion

Phytosociological observations showed that climatic conditions play an important role in changing the Phytosociology. A large number of plant species start their germination and growth during early winter season because of sufficient moisture in the soil and favorable condition of temperature for plant growth.

Plant sociological characters such as frequency, density, abundance and IVI were exclusively influenced by the natural as well as biotic stress prevailing at the present study sites. Maximum values of frequency and density were recorded in rainy season and minimum in summer season. Plants have shown comparatively higher frequency and density, consequently higher degree on dispersion and numerical strength of species in winter season on account of most suitable climatic conditions. It seems, in such natural communities, that

stability appears to depend on the balance between the stability and variability of the environment. Ecosystem conservation work can be done using the existing knowledge and assessing the disturbance impacts/regimes by way of investigating and inventorying vegetation richness of the area. The parameters like causes of fire, human intervention degree of degradation, existing vegetation richness and socio-economic pressure will be taken into consideration for predicting the future floristic diversity conservation.

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http://www.environment.gov.au/node/21579

Annexure I

PHYTOSOCIOLOGICAL ANALYSIS OF THE TREE SPECIES

S.No.	Name of the Species	Density/ha	Abundance	Frequency (%)	IVI
1	*Acer spp*	20	1	20	7.65
2	*Aesculusindica*	30	1	30	21.78
3	*Alnusnitida*	210	3.5	60	92.89
4	*Cedrusdeodara*	60	2	30	18.4
5	*Celtisaustralis*	40	1.33	30	13.17
6	*Juglansregia*	40	1.33	30	18.37
7	*Morusserrata*	20	1	20	8.15
8	*Oleacuspidata*	90	1.5	60	29.42
9	*Populusciliata*	30	1.5	20	10.42
10	*Prunusarmeniaca*	10	1	10	3.79
11	*Quercus ilex*	170	2.13	80	56.17
12	*Rhododendron arboreum*	40	0.8	50	19.78

PHYTOSOCIOLOGICAL ANALYSIS OF THE UNDER STOREY SPECIES

S. No.	Name of the Species	Density/ha	Abundance	Frequency (%)	IVI
1	*Berberislycium*	3056	3.33	82.5	54.94
2	*Buddlejaasiatica*	889	2.67	30	17.07
3	*Cotoneaster acuminata*	1500	3.38	40	23.67
4	*Daphne oleoides*	1083	1.39	70	21.2
5	*Desmodiummicrophyllum*	778	2.33	30	15.62
6	*Debregeasiahypoleuca*	1167	3.82	27.5	23.2
7	*Loniceraquinquelocularis*	667	2.18	27.5	14.52
8	*Myrsineafricana*	2083	3.57	52.5	28.67
9	*Plectranthusrugosus*	2389	2.77	77.5	36.02
10	*Prinsepiautilis*	1778	2.29	70	40.46
11	*Rhamnusvirgatus*	806	3.63	20	16.2
12	*Rosa mochata*	278	1.11	22.5	8.42

PHYTOSOCIOLOGICAL ANALYSIS OF THE HERBACEOUS SPECIES (PRE-MONSOON)

S. No.	Name of the Species	Density/m^2	Abundance	Frequency (%)	IVI
1	*Ajugabracteosa*	0.03	1	3.3	2.3
2	*Artemisia dracunculus*	0.27	1.5	18.3	22.6
3	*Artemisia gmelli*	0.07	1.3	5	4.4
4	*Bergeniaciliata*	0.08	1.7	5	5.4
5	*Chenopodium album*	0.07	1.3	5	4.2
6	*Cynodondactylon*	0.08	1.3	6.7	5.7
7	*Duchesneaindica*	0.02	1	1.7	1.7
8	*Foeniculumvulgare*	0.05	1	5	3.8
9	*Fragariavesca*	0.02	1	1.7	1.3
10	*Loniceraquinquelocularis*	0.28	1.7	16.7	75.9
11	*Menthalongifolia*	0.05	1.5	3.3	3.9
12	*Micromeriabiflora*	0.03	2	1.7	1.8
13	*Nasturtium officinale*	0.12	1.4	8.3	8
14	*Plantagolanceolata*	0.07	1.3	5	4.7
15	*Plantago major*	0.05	3	1.7	3
16	*Poasp*	0.08	1	8.3	5.6
17	*Polygonumcapitatum*	0.22	1.2	18.3	16
18	*Rumexhastatus*	0.23	1.3	18.3	13.9
19	*Rumexnepalensis*	0.2	1.5	13.3	13.4
20	*Salvia moorcroftiana*	0.17	1.1	15	11.4
21	*Solanumnigrum*	0.15	1.1	13.3	10.2
22	*Tagetesminuta*	0.15	1.5	10	9.4
23	*Thalictrumfoliolosum*	0.18	1.1	16.7	12.6
24	*Thymus linearis*	0.12	1.2	10	7.5
25	*Trifoliumpratense*	0.17	1.1	15	12
26	*Trifoliumrepens*	0.13	1.3	10	9.4
27	*Valerianajatamansi*	0.32	2.1	15	20.5
28	*Viola canescens*	0.15	1.3	11.7	9.6

PHYTOSOCIOLOGICAL ANALYSIS OF THE HERBACEOUS SPECIES (MONSOON)

S. No.	Name of the Species	Density/m^2	Abundance	Frequency (%)	IVI
1	*Ajugabracteosa*	0.17	1.3	13	4
2	*Ajugaparviflora*	0.13	0.5	25	5.4
3	*Artemisia dracunculus*	0.67	1.3	50	25.3
4	*Artemisia gmelli*	0.42	0.9	47	13.3
5	*Bergeniaciliata*	0.08	1.7	5	2.2
6	*Brassica campestris*	0.17	0.7	25	6.2
7	*Cannabis sativa*	0.17	0.5	33	8.2
8	*Carumcarvi*	0.08	1.7	5	1.8
9	*Chenopodium album*	0.2	0.8	25	6.4
10	*Chenopodiumfoliolosum*	0.08	0.6	13	3.2
11	*Coriandrumsativum*	0.1	2	5	2
12	*Cynodondactylon*	0.08	1	8	2.5
13	*Delphinium denudatum*	0.35	5.3	7	6.6
14	*Duchesneaindica*	0.17	1	17	7.6
15	*Foeniculumvulgare*	0.27	3.2	8	5.5
16	*Fragariavesca*	0.22	1.4	15	6.1
17	*Loniceraquinquelocularis*	0.38	1.5	25	52.2
18	*Menthalongifolia*	0.17	1.3	13	5.9
19	*Micromeriabiflora*	0.15	0.7	22	5.2
20	*Nasturtium officinale*	0.35	1.8	20	9.2
21	*Plantagolanceolata*	0.18	0.5	35	8.3
22	*Plantago major*	0.32	1.5	22	9.7
23	*Poasp*	0.08	0.4	22	4
24	*Polygonumcapitatum*	0.45	1.6	28	12.3
25	*Rumexhastatus*	0.35	1.4	25	7.7
26	*Rumexnepalensis*	0.45	2.1	22	11.3
27	*Salvia moorcroftiana*	0.17	0.9	18	5
28	*Solanumnigrum*	0.57	4.3	13	10
29	*Tagetesminuta*	0.13	0.6	22	5.2
30	*Thalictrumfoliolosum*	0.38	2.3	17	7.8
31	*Thymus linearis*	0.32	0.8	38	9.5
32	*Trifolium minus*	0.22	2.6	8	4.7
33	*Trifoliumpratense*	0.17	1.1	15	4.8

34	*Trifoliumrepens*	0.13	1.3	10	3.9
35	*Valerianajatamansi*	0.38	4.6	8	9.2
36	*Viola canescens*	0.28	1.1	27	7.8

PHYTOSOCIOLOGICAL ANALYSIS OF THE HERBACEOUS SPECIES (POST- MONSOON)

S. No.	Name of the Species	Density/m^2	Abundance	Frequency (%)	IVI
1	*Artemisia dracunculus*	0.33	1.11	30	16.41
2	*Cannabis sativa*	0.4	2	20	13.91
3	*Cynodondactylon*	0.73	1.16	63.33	26.79
4	*Menthalongifolia*	0.73	1.22	60	32.28
5	*Micromeriabiflora*	0.27	1.33	20	8.65
6	*Origanumvulgare*	0.47	1.27	36.67	71.43
7	*Plantago major*	0.4	1.2	33.33	16.44
8	*Polygonumcapitatum*	0.17	2.5	6.67	5.01
9	*Rumexhastatus*	1.33	1.33	100	39.83
10	*Rumexnepalensis*	0.5	1.15	43.33	19.47
11	*Salvia moorcroftiana*	0.07	2	3.33	1.85
12	*Solanum*sp	0.53	1.33	40	17.3
13	*Tagetesminuta*	0.6	1.2	50	21.57
14	*Trifoliumrepens*	0.23	1.17	20	9.04