

PLANT COMMUNITY STRUCTURE AND SPECIES DIVERSITY IN BALKASSAR, DISTRICT CHAKWAL PAKISTAN

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Abstract

The present study was conducted in Balkassar, a rapidly growing village in Chakwal, to analyze the plant community structure and species diversity of the area, which had previously been undocumented. Using the Quadrat method, 45 plant species were identified and studied from 15 distinct sites based on topography, altitude, and floristic composition. Among these, the herbaceous flora displayed the highest diversity compared to shrubs and trees, suggesting a significant influence of climatic factors on the vegetation. Dominant families identified included Amaranthaceae, Asteraceae, Poaceae, Euphorbiaceae, Malvaceae, Apocynaceae, Fabaceae, and Moraceae. The most dominant species across the sites had the highest Importance Value Index (IVI), highlighting their ecological prevalence. Sorenson's Community Index was used to assess the similarity among the plant communities, revealing a notable degree of homogeneity across some sites, while others exhibited more distinct floristic compositions. This study underscores the dynamic nature of plant diversity in Balkassar, driven by human activity, land use changes, and climatic variations. Recommendations include the need for sustainable land management practices to conserve and maintain the region's diverse vegetation.

Keywords: Phytosociology, Species Diversity, Plant Communities, Herbs, Shrubs, Trees, Importance Value Index (IVI), Herbarium, Quadrat Method, Vegetation Analysis, Conservation Strategies.

Introduction

Balkassar is a city, an administrative subdivision, of Chakwal, District in the Punjab Province of Pakistan. It is situated 95 km south of the federal capital, Islamabad. It has a big interchange linked to Motorway M2. This place is located in Jhelum, Punjab, Pakistan, its geographical coordinates are 32° 56' 0" North, 72° 39' 0" East. The estimate terrain elevation above sea level is 528 meters. The Latitude is 32°56'15.25" and Longitude is 72°38'38.55".

The area of Balkassar is divided into mountainous and unleveled area in which rocks are bare and land which is extremely eroded and there are big gullies and cut present in the whole area. There are alluvial deposits of soil in few regions of area. There are solid and broad deposits of sand. Thin layer of sand and

gravels are also present around the different sites. The drilling for supply of ground water is not good in different tract of the Balkassar region.

The composition of ground water of Balkassar is made of sodium and carbonates so the water is saline but not sodic. The ground water of Chakwal area has

high salt concentration may be due to closeness to the famous salt range (Khan et al., 2002).

The frost drought and hot winds are the physical factor of Balkassar. The soil is shallow and steep sloppy in most regions. The PH range of soil in Balkassar is from silt loam to loam in the range of 7-9. There is fluctuation in air temperature throughout the year. The temperature of winter normally ranges between 4° C and 25° C and summer temperatures average between 15° C and 40° C. The hottest month is June and the coldest month is December of the year. The average annual rainfall is 558 to 635 mm and more than 70% of annual precipitation falls in the summer months.

The climate of the Balkassar area is semiarid type with almost level topography. The biological spectrum obtained in the present study reflects aridity. In some areas of Balkassar there is scrubby vegetation with scattered trees. Species richness and life forms of plants are related to altitudinal and rainfall gradients. There is low percentage of tree species which show intensive deforestation. The investigated area has the potential to support the growth of different life form of plants which are trees and shrubs yet human and

cattle have degraded the overall floristic and vegetation in some regions.

The present study was aimed as study of plant community structure and species diversity from different sites of Balkassar region. The objectives of this study were to find the community structure and estimate the most frequent species in the study area. Survey of floral diversity in respected region was helpful in study of phytosociology of different kinds of plants in Balkassar regions. It provides the floristic inventory of plants of Balkassar region.

Vegetation life forms reflect the climatic conditions of a region and are essential for understanding plant community structure and geographical distribution. Such studies also aid in categorizing vegetation types at the community level, contributing to global vegetation classification (Raunkiaer, 1934; Wang et al., 2017; Smith et al., 2019).

To study the plant association, leaf size of plant species are used as study parameter also helpful in different physiological processes of plants and plant communities. (Oosting, 1956)

All plant species which are present in a specific geographic region is the flora of that area which also shows the geological period and also that inhabit a particular ecosystem of that area. The number of species, number of individuals and the vegetation of the area refer to their distribution and size of each of the relative importance; all are included in the flora. (Ali, 2008).

The effect of altitude and topographical variables are not directly influence the vegetation, there importance depend on correlation with some direct or resource gradients. Light and nutrients (eg. phosphorus and nitrogen etc.) are resource variables which are consumed by plants. Patch area and site age are some instance significantly relates with species diversity (Hermey & Corneils, 2000).

The vegetation communities which are related with urban landscape structures have been studied, especially in Asian or Tropical countries (Alvey, 2006).

The natural vegetation and fragmentation are badly collapsed in urban regions over the past several decades. Ecological and environmental functions are facilitated by natural vegetation and fragmentation of ecosystem. (Benedict & Mc Mahon, 2002).

In vegetation ecology and community analysis of plants there are different operational practices are used in term of ordination and taxonomy. Which are very helpful in vegetation analysis of different regions in respected regions (Zhang, 2004).

There is no uniform climate in the respected area because of high variation and altitudinal ranges. Winters are mild and summers are extremely hot.

From June to September there are heavy rainfalls of monsoon. There is dense vegetation in understory regions especially where the average rainfall is high. (Siddiqui et al., 2010)

Most plants live in community structure, there are forces which increase and decrease the natural tendency of plant species. At a local scale, parts of a plants like fruit and seed come close to parent plants, vegetative reproduction of plants also reproduce plants in immediate locality of other of the same species. With the passage of time the patchiness of plant species increases in the respected regions. Furthermore, the environmental variation shows correlation so that sites close to one plant have a tendency to be good for another plant of species. (Frelich et al., 1993)

(Lachowski, 1995) established guidelines for map vegetation in the United States by using remotely sensed digital imagery. These all guidelines help in describing mapping, forest plan monitoring and mapping of ecological units. The plant community is best studied by phytosociological analysis. For understanding the functioning of any community, it is an important study for any piece of vegetation. It provides the basis of ecological study.

There are multivariate programs used for analysis of floral data which are computer based and these programs help to study ecological data in a good way. Different statistical programmes were used for classification of vegetation on the basis of their characteristics. Now ecologists can easily analyse the community structure and species diversity. The effects of environmental factors on vegetation easily analysed and observed by using statistical approaches. (Bergmeier et al., 2002)

The ecosystem of any area is mixture of different ecological processes which include the biodiversity and biorichness of the area. The biodiversity of ecosystem contains four major components which include diversity of genes, diversity of species, diversity of ecosystem and diversity of ecological processes. There is a rich floral diversity in Pakistan which is the indication of climatic condition, soil and other biological characters. (Kilic and Arslan, 2010).

Materials and Methods

The study was conducted in the Balkassar area, located in Chakwal. The area was divided into 15 sites based on topographic maps, physiognomy, altitude, and floristic composition. These sites were selected following frequent surveys of the region, ensuring a representative distribution of the plant communities. Each site was spaced 100 meters apart to avoid overlap of plant species between adjacent sites. For vegetation analysis, quadrat methods were

employed. Three large stands, each measuring 100 x 100 m, were established at each of the 15 sites. Within each stand, 15 sub-quadrats of 10 x 10 m were randomly placed to capture variability in the vegetation structure. The size of the quadrats was selected based on the species-area curve method, which is commonly used to determine the optimal size of quadrats for studying plant diversity (Mueller-Dombois & Ellenberg, 1974). Data were collected during the spring and monsoon seasons to capture seasonal variation in plant composition. For each identified species, a complete specimen was collected in triplicate, dried, preserved, and mounted on standard herbarium sheets. Plant density, frequency, and cover were recorded for each sub-quadrat, following the protocols of Mueller-Dombois and Ellenberg (1974). Community similarity was calculated to compare the plant communities across the study area. The Index was calculated after Sorenson (1948) as follows by using important values.

$$Is = \frac{2C}{A+B} \times 10$$

This index helps assess the floristic similarity between the different sites. The degree of homogeneity in the plant communities was evaluated by classifying plants into various frequency classes. This classification, based on the work of Raunkiaer (1934), provides insights into the uniformity of species distribution within different communities. Raunkiaer's methodology was followed, with quadrats systematically laid in lower-altitude areas and randomly in hilly sites to account for varying ecological conditions. Quantitative attributes, including plant density, frequency, and cover, were measured for each species within the quadrats. These attributes were used to determine the Importance Value Index (IVI) for each species in the community, which reflects their ecological dominance and significance.

Results

1- Climate of Balkassar of district Chakwal:

In table 1 climate condition of Balkassar, Chakwal was shown. Maximum rainfall was observed in March 2016 and minimum rainfall was observed in December 2016. The average rainfall of these months effects the overall vegetation of Balkassar region. There was maximum vegetation of herb species observed in March. The herb, shrub and tree vegetation of the area was totally affected by climatic

condition and varied from site to site in Balkassar. The maximum temperature was observed in the month of April and minimum temperature was observed in the month of December.

2- Community Similarity:

Table 2 shows Sorenson Index of community similarity in which different sites show similar communities. Majority of communities show similarity with each other because some species were very common and dominant species of the Balkassar which were present in majority of study sites. There is a pair wise comparison of the sites. 0 means no similarity at all, 1 mean 100% similarity or 0.5 means 50% similarity between two sites. The majority of communities exhibit 40% to 50% similarity with each other.

3- Degree Of Homogeneity:

Table 3 clearly revealed that majority of sites had poor degree of homogeneity. Site 1, site 4, site 5 and site 9 had shown high frequency in class A. Site 1, site 3, site 4 and site 12 had shown high frequency in class B. Site 2, site 3, site 6, site 7, site 8, site 13, site 14 and site 15 had shown maximum frequency in class C. Site 1 and site 12 had shown maximum frequency value in class D. Site 3 and site 11 had shown maximum frequency value in class E. Site 2, site 3, site 11 and site 13 had shown some degree of homogeneity, other sites had shown high frequency values in class B and C, so these sites shown less degree of homogeneity than others.

Table 4 show the dominant herb species in 15 selected sites. The dominant herb species were those species which had high IVI value. The dominant species were given ranks of 1st 2nd and 3rd. The dominant species of herb were *Amaranthus viridus*, *Euphorbia heliscopia*

, *Malva parviflora*, *Solanum nigrum*, *Oxalis corniculata* and *Alternanthera pungens* which had shown maximum diversity in different study sites.

Table 5 show the dominant shrub species in 15 selected sites. The most common species of shrubs which were identified at most of the selected sites were *Calotropis procera*, *Lantana camara*, *Ziziphus mauritiana*, *Dalbergia sissoo* and *Dedonea viscosa*. These shrub species were most common and dominant species of the 15 communities and had shown maximum IVI value. Table 6 show dominant species of trees in 15 selected sites which were

arranged in 15 different communities. The most common and dominant tree species were *Eucalyptus alba*, *Dalbergia sisso*, *Acacia nilotica* and *Ziziphus mauritiana*. These tree species were present at mostly sites of Balkassar. The area of Balkassar is rich in some tree species which produce dominant plant communities in respected area.

Discussion

Community structure, composition, and vegetative function are critical ecological attributes that vary in response to environmental factors. These variations in vegetation structure, richness, diversity, and distribution are closely related to environmental variables such as geographical location, productivity, and evolutionary competition (Li et al., 2022; Zhang

The Sorenson Community Index revealed a significant degree of similarity among the 15 plant communities, while the homogeneity degree calculation showed that most sites had a low degree of homogeneity. The diversity of herb species was notably influenced by seasonal changes, with the high rainfall in March 2016 contributing to a peak in herb diversity. Common herb species such as *Solanum nigrum*, *Chenopodium album*, *Alternanthera pungens*, *Cynodon dactylon*, *Oxalis corniculata*, and *Amaranthus viridis* dominated the area. Dominant shrub species included *Lantana camara*, *Ziziphus mauritiana*, and *Calotropis procera*, while *Ziziphus mauritiana*, *Acacia nilotica*, *Acacia modesta*, *Dalbergia sissoo*, and *Eucalyptus alba* were the most common tree species.

Recent studies have also assessed plant species and community diversity in similar regions. Khan et al. (2022) conducted a study in the Narran Valley and observed 198 plant species from 68 families across 144 sampling sites. They identified 15 plant communities, which parallels the findings in the

et al., 2023). The present study investigates the ecological attributes and floral diversity of the Balkassar area.

Phytosociological analysis of the Balkassar area revealed that herb species dominate over shrubs and trees, indicating a rich herb diversity in the region. A total of 45 plant species, distributed across 30 families, were recorded from the 15 study sites in Balkassar, district Chakwal. Of these, 26 species were herbs, 10 species were shrubs, and 9 species were trees. Dominant families in the area included Amaranthaceae, Asteraceae, Poaceae, Euphorbiaceae, Malvaceae, Apocynaceae, Fabaceae, and Moraceae, which were also reported by Stewart (1972) in Pakistan. Some herb species, though observed in the study area, were not recorded in the quadrats.

Balkassar area. Similarly, Ahmed et al. (2021) studied floral diversity in the Royle forests of Lower Dir, Pakistan, using 30 sampling sites. They recorded 10 plant communities based on importance value and floristic composition, similar to the Balkassar study but with differing quantitative values.

Hussain et al. (2022) focused on the district Chakwal, recording 69 plant species across 4 sampling sites in Nurpur. They calculated the density, frequency, and importance value index for all species, recognizing 12 plant communities. This study highlights regional variations in species composition compared to the Balkassar region.

Sharma et al. (2023) studied the floral diversity and vegetation patterns in the Sangla Valley, Northwest Himalaya. They documented 15 plant communities with 320 species, 199 genera, and 75 families. The dominant families identified were Ranunculaceae, Apiaceae, and Rosaceae, showing distinct vegetation patterns compared to the Balkassar area.

Table-1 Rainfall (mm), Minimum and Maximum temperature (°C) of Balkassar from November 2015 to April 2016

Date	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16
Rainfall mm(mm)	0.28mm	0.00 mm	0.15 mm	1.98 mm	2.17 mm	0.01 mm
Minimum Temperature(°C)	23.23(°C)	19.15(°C)	16.70(°C)	20.95(°C)	23.66(°C)	31.21(°C)
Maximum Temperature (°C)	10.05((°C)	5.27(°C)	2.48(°C)	5.83(°C)	10.69(°C)	15.52(°C)



Table-2 Sorenson Index of Community Similarity between 15 selected sites of Balkassar area.

Sorenson Index of Community Similarity														
Site.	Site.	Site.	Site.	Site.	Site.	Site.	Site.	Site.	Site.	Site.	Site.	Site.	Site.	Site.
	01	02	03	04	05	06	07	08	09	10	11	12	13	14
Site.	0.5													
02	5													
Site.	0.5	0.4												
03	4	1												
Site.	0.6	0.3	0.4											
04	1	9	4											
Site.	0.5	0.3	0.3	0.4										
05	1	6	7	3										
Site.	0.5	0.4	0.4	0.4	0.4									
06	0	2	1	1	2									
Site.	0.5	0.5	0.5	0.4	0.5	0.4								
07	8	3	3	8	5	7								
Site.	0.5	0.5	0.4	0.4	0.5	0.4	0.4							
08	5	6	9	7	8	9	2							
Site.	0.5	0.4	0.4	0.5	0.4	0.4	0.5	0.5						
09	1	1	7	3	9	7	5	4						
Site.	0.5	0.5	0.5	0.5	0.5	0.4	0.5	0.4	0.4					
10	7	1	2	0	3	1	3	3	9					
Site.	0.6	0.4	0.4	0.4	0.4	0.5	0.3	0.4	0.4	0.5				
11	0	5	5	4	6	0	7	8	0	7				
Site.	0.5	0.3	0.4	0.5	0.4	0.4	0.4	0.5	0.4	0.4	0.4			
12	5	7	0	6	5	1	5	3	0	9	8			
Site.	0.5	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.3		
13	8	7	0	7	5	8	0	4	7	6	7	8		
Site.	0.5	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.3	
14	5	6	0	5	2	6	5	7	9	5	2	3	7	
Site.	0.5	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.5	0.4	0.4	0.3	0.4
15	5	4	7	7	6	4	8	5	7	6	3	0	7	8

Table -3 Homogeneity percentage of species in different frequency classes of 15 stands in Balkassar.

	A >	B >	C >	D <	E
No. of sites	1-20%	21-40%	41-60%	61-80%	81-100%
SITE 1	8	18	3	3	1
SITE 2	-	7	11	8	6
SITE 3	2	11	10	5	7
SITE 4	7	9	9	6	1
SITE 5	7	5	6	10	2
SITE 6	3	8	15	4	1
SITE 7	2	3	13	6	3
SITE 8	2	4	13	5	2
SITE 9	9	4	8	7	4
SITE 10	3	6	8	9	3
SITE 11	2	5	8	4	9
SITE 12	-	8	7	10	5
SITE 13	5	2	12	5	6
SITE 14	2	5	10	6	4
SITE 15	5	4	9	6	4

Table-4 Herb communities at 15 selected sites of Balkassar.

HERBS	Dominant species	R.D	R.F	R.C	IVI	Rank
COMMUNITY 1	<i>Chenopodium album</i>	101.94	5.75	54.45	162.14	1 st
	<i>Alternanthera pungen</i>	94.66	5.75	52.61	153.01	2 nd
	<i>Amaranthus viridus</i>	123.79	6.90	20.83	151.51	3 rd
COMMUNITY 2	<i>Malva parviflora</i>	7.86	8.29	50.70	66.85	1 st
	<i>Convululus arvensis</i>	2.71	4.97	50.70	58.39	2 nd
	<i>Euphorbia heliscopia</i>	5.42	4.42	44.65	54.49	3 rd
COMMUNITY 3	<i>Oxalis corniculata</i>	10.45	8.76	61.00	80.20	1 st
	<i>Euphorbia thymifolia</i>	5.97	8.13	47.32	61.42	2 nd
	<i>Sonchus oleraceae</i>	6.27	5.63	44.53	56.43	3 rd
COMMUNITY 4	<i>Pathenium hystrophorous</i>	8.95	6.76	72.06	87.77	1 st

COMMUNITY 5	<i>Anagalis arvensis</i>	8.64	7.44	50.04	66.12	2 nd
	<i>Sonchus asper</i>	5.56	6.09	51.59	63.24	3 rd
	<i>Amaranthus viridus</i>	6.05	6.08	75.15	87.29	1 st
	<i>Euphorbia heliscopia</i>	6.34	5.47	73.11	84.92	2 nd
COMMUNITY 6	<i>Chenopodium album</i>	6.34	6.08	63.31	75.73	3 rd
	<i>Euphorbia heliscopia</i>	6.52	6.25	89.42	102.19	1 st
	<i>Malvestum coromedanum</i>	7.11	6.25	68.36	81.72	2 nd
COMMUNITY 7	<i>Pathenium hysterophorous</i>	7.70	5.56	64.69	77.95	3 rd
	<i>Solanum nigrum</i>	4.20	5.64	214.93	224.77	1 st
	<i>Malva parviflora</i>	9.79	6.34	77.81	93.95	2 nd
COMMUNITY 8	<i>Tribulus terrestris</i>	7.69	8.46	48.40	64.56	3 rd
	<i>Solanum nigrum</i>	6.09	5.65	164.76	176.50	1 st
	<i>Alternanthera pungen</i>	6.45	8.07	87.66	102.18	2 nd
COMMUNITY 9	<i>Anagalis arvensis</i>	8.96	7.26	68.26	84.48	3 rd
	<i>Alternanthera pungen</i>	6.71	7.38	75.60	89.69	1 st
	<i>Oxalis corniculata</i>	11.32	9.40	66.58	87.30	2 nd
COMMUNITY 10	<i>Convululus arvensis</i>	2.83	5.37	75.60	83.80	3 rd
	<i>Alternanthera pungen</i>	7.14	8.70	127.98	143.83	1 st
	<i>Anagalis arvensis</i>	9.52	6.96	94.99	111.47	2 nd
COMMUNITY 11	<i>Chenopodium album</i>	9.92	9.57	63.62	83.11	3 rd
	<i>Solanum nigrum</i>	5.03	4.90	114.10	124.03	1 st
	<i>Oxalis corniculata</i>	11.32	9.79	65.66	86.78	2 nd
COMMUNITY 12	<i>Malva parviflora</i>	8.18	6.30	67.67	82.14	3 rd
	<i>Solanum nigrum</i>	4.01	3.45	92.04	99.49	1 st
	<i>Alternanthera pungen</i>	6.58	6.90	52.97	66.45	2 nd
COMMUNITY 13	<i>Convululus arvensis</i>	3.43	5.75	52.97	62.15	3 rd
	<i>Solanum nigrum</i>	4.56	4.43	103.20	112.20	1 st
	<i>Alternanthera pungen</i>	5.96	6.96	64.91	77.84	2 nd
COMMUNITY 14	<i>Oxalis corniculata</i>	9.36	8.86	55.85	74.07	3 rd
	<i>Oxalis corniculata</i>	9.27	8.29	36.80	54.35	1 st
	<i>Alternanthera pungen</i>	5.41	7.10	30.76	43.27	2 nd
COMMUNITY 15	<i>Sonchus oleraceae</i>	6.44	5.33	30.76	42.52	3 rd
	<i>Solanum nigrum</i>	4.60	4.61	88.05	97.25	1 st
	<i>Euphorbia heliscopia</i>	6.03	5.26	57.00	68.30	2 nd
	<i>Convululus arvensis</i>	3.16	5.92	55.38	64.46	3 rd

Table-5 Shrub communities at 15 selected sites of Balkassar

SHRUBS	Dominant Species	R.D	R.F	R.C	IVI	Rank
COMMUNITY 1	<i>Lantana camara</i>	26.67	18.18	32.59	77.44	1 st
	<i>Ziziphus mauritiana</i>	26.67	22.73	18.33	67.72	2 nd
	<i>Dedonea viscosa</i>	16.67	18.18	11.73	46.58	3 rd
COMMUNITY 2	<i>Lantana camara</i>	17.65	16.13	26.76	60.53	1 st
	<i>Carissa apaca</i>	11.76	12.90	26.76	51.43	2 nd
	<i>Calotropis procera</i>	20.59	16.13	8.39	45.11	3 rd
COMMUNITY 3	<i>Dalbergia sisso</i>	18.52	18.52	15.40	52.43	1 st
	<i>Carissa apaca</i>	11.11	11.11	27.10	49.32	2 nd
	<i>Dedonea viscosa</i>	14.81	14.81	15.40	45.03	3 rd
COMMUNITY 4	<i>Ziziphus mauritiana</i>	23.81	15.79	16.87	56.47	1 st
	<i>Carissa apaca</i>	14.29	15.79	25.10	55.17	2 nd
	<i>Calotropis procera</i>	9.52	10.53	27.14	47.19	3 rd
COMMUNITY 5	<i>Dalbergia sisso</i>	31.25	26.67	46.26	104.17	1 ST
	<i>Carissa apaca</i>	12.50	13.33	21.53	47.36	2 ND
	<i>Mallotus phillipensis</i>	18.75	20.00	1.65	40.40	3 RD
COMMUNITY 6	<i>Calotropis procera</i>	20.25	21.43	20.44	62.12	1 st
	<i>Dalbergia sisso</i>	15.19	17.86	24.65	57.70	2 ND
	<i>Ziziphus mauritiana</i>	20.25	14.29	20.87	55.41	3 RD
COMMUNITY 7	<i>Calotropis procera</i>	30.65	25.00	24.07	79.71	1 st
	<i>Lantana camara</i>	20.97	20.83	23.58	65.39	2 nd
	<i>Dalbergia sisso</i>	16.13	20.83	24.31	61.27	3 rd
COMMUNITY 8	<i>Lantana camara</i>	26.09	26.09	53.98	109.48	1 st
	<i>Ziziphus mauritiana</i>	26.09	21.74	16.49	65.69	2 nd
	<i>Querous leucotrichophora</i>	17.39	17.39	12.83	45.90	3 rd
COMMUNITY 9	<i>Calotropis procera</i>	48.57	41.18	74.65	164.40	1 st
	<i>Ziziphus mauritiana</i>	20.00	17.65	8.74	46.39	2 nd
	<i>Dalbergia sisso</i>	11.43	11.76	6.46	29.65	3 rd
COMMUNITY 10	<i>Calotropis procera</i>	33.90	29.63	39.35	102.88	1 st
	<i>Lantana camara</i>	16.95	18.52	36.97	72.43	2 nd
	<i>Dalbergia sisso</i>	22.03	22.22	12.98	57.24	3 rd
COMMUNITY 11	<i>Ziziphus mauritiana</i>	30.00	29.41	39.43	98.84	1 st
	<i>Dalbergia sisso</i>	27.50	26.47	34.41	88.38	2 nd
	<i>Calotropis procera</i>	20.00	20.59	9.08	49.66	3 rd
COMMUNITY 12	<i>Calotropis procera</i>	33.33	32.00	32.02	97.35	1 st

COMMUNITY 13	<i>Lantana camara</i>	16.67	16.00	33.00	65.67	3rd
	<i>Dalbergia sisso</i>	22.92	24.00	26.41	73.32	2nd
	<i>Calotropis procera</i>	50.00	47.62	45.51	143.13	1st
	<i>Ziziphus mauritiana</i>	35.42	33.33	45.00	113.75	2nd
COMMUNITY 14	<i>Dedonea viscosa</i>	6.25	4.76	2.66	13.68	3rd
	<i>Dalbergia sisso</i>	31.91	30.43	32.37	94.72	1st
	<i>Ziziphus mauritiana</i>	31.91	26.09	30.77	88.77	2nd
COMMUNITY 15	<i>Lantana camara</i>	12.77	13.04	12.24	38.05	3rd
	<i>Calotropis procera</i>	35.48	33.33	61.93	130.75	1st
	<i>Justicia adhatoda</i>	25.81	20.00	4.00	49.81	2nd
	<i>Ziziphus mauritiana</i>	12.90	13.33	8.30	34.54	3rd

Table-6 Tree communities at 15 selected sites of Balkassar.

TREES COMMUNITY	Dominant Species	R.D	R.F	R.C	IVI	Rank
COMMUNITY 1	<i>Eucalyptus alba</i>	24.24	20.83	16.65	61.72	1st
	<i>Acacia nilotica</i>	18.18	16.67	16.90	51.75	2nd
	<i>Ziziphus mauritiana</i>	12.12	16.67	13.78	42.57	3rd
COMMUNITY 2	<i>Eucalyptus alba</i>	15.79	15.38	27.35	58.52	1st
	<i>Acacia modesta</i>	18.42	15.38	24.35	58.16	2nd
	<i>Ziziphus mauritiana</i>	18.42	15.38	19.21	53.01	3rd
COMMUNITY 3	<i>Eucalyptus alba</i>	17.65	18.52	19.69	55.85	1st
	<i>Acacia nilotica</i>	14.71	14.81	25.55	55.07	2nd
	<i>Dalbergia sisso</i>	20.59	18.52	11.61	50.72	3rd
COMMUNITY 4	<i>Ziziphus mauritiana</i>	13.33	7.69	19.48	40.51	1st
	<i>Pongamia glabra</i>	13.33	15.38	9.52	38.24	2nd
	<i>Ficus carica</i>	6.67	7.69	22.74	37.10	3rd
COMMUNITY 5	<i>Eucalyptus alba</i>	22.22	20.00	25.71	67.93	1st
	<i>Acacia modesta</i>	14.81	15.00	31.39	61.20	2nd
	<i>Dalbergia sisso</i>	22.22	20.00	6.00	48.23	3rd
COMMUNITY 6	<i>Dalbergia sisso</i>	18.52	17.65	26.63	62.79	1st
	<i>Eucalyptus alba</i>	22.22	23.53	15.31	61.06	2nd
	<i>Acacia nilotica</i>	11.11	11.76	35.69	58.56	3rd
COMMUNITY 7	<i>Dalbergia sisso</i>	20.00	14.29	39.64	73.93	1st
	<i>Eucalyptus alba</i>	23.33	23.81	20.59	67.73	2nd
	<i>Ziziphus mauritiana</i>	16.67	14.29	12.98	43.93	3rd
COMMUNITY 8	<i>Dalbergia sisso</i>	21.43	23.81	23.11	68.35	1st

COMMUNITY 9	<i>Eucalyptus alba</i>	17.86	14.29	26.62	58.76	2 nd
	<i>Acacia modesta</i>	17.86	19.05	8.94	45.84	3 rd
	<i>Dalbergia sisso</i>	23.33	18.18	26.40	67.91	1 st
COMMUNITY 10	<i>Eucalyptus alba</i>	26.67	22.73	9.23	58.63	2 nd
	<i>Dalbergia sisso</i>	23.33	18.18	26.40	67.91	1 st
	<i>Dalbergia sisso</i>	18.18	12.50	22.54	53.23	1 st
COMMUNITY 11	<i>Acacia modesta</i>	15.91	15.63	16.32	47.85	2 nd
	<i>Eucalyptus alba</i>	13.64	15.63	15.90	45.16	3 rd
	<i>Dalbergia sisso</i>	28.13	20.00	34.92	83.04	1 st
COMMUNITY 12	<i>Eucalyptus alba</i>	21.88	20.00	16.06	57.94	2 nd
	<i>Ziziphus mauritiana</i>	18.75	20.00	7.56	46.31	3 rd
	<i>Dalbergia sisso</i>	22.86	20.83	53.98	97.68	1 st
COMMUNITY 13	<i>Eucalyptus alba</i>	28.57	20.83	10.86	60.27	2 nd
	<i>Acacia nilotica</i>	17.14	16.67	13.41	47.22	3 rd
	<i>Dalbergia sissoo</i>	22.22	21.74	30.78	74.75	1 st
COMMUNITY 14	<i>Eucalyptus alba</i>	30.56	21.74	9.07	61.37	2 nd
	<i>Acacia modesta</i>	16.67	13.04	27.45	57.16	3 rd
	<i>Eucalyptus alba</i>	21.43	21.74	21.35	64.51	1 st
COMMUNITY 15	<i>Dalbergia sisso</i>	21.43	21.74	20.20	63.37	2 nd
	<i>Acacia modesta</i>	21.43	21.74	16.07	59.24	3 rd
	<i>Dalbergia sissoo</i>	25.64	21.74	36.44	83.82	1 st
COMMUNITY 15	<i>Ziziphus mauritiana</i>	17.95	13.04	29.55	60.55	2 nd
	<i>Eucalyptus alba</i>	20.51	21.74	8.57	50.82	3 rd

Fig.1 Rainfall, Minimum and Maximum temperature of Balkassar from November 2015 to April 2016.

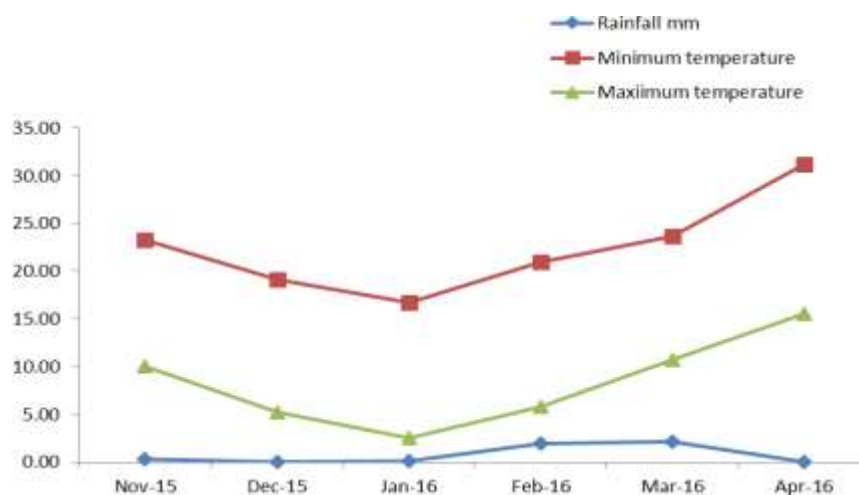
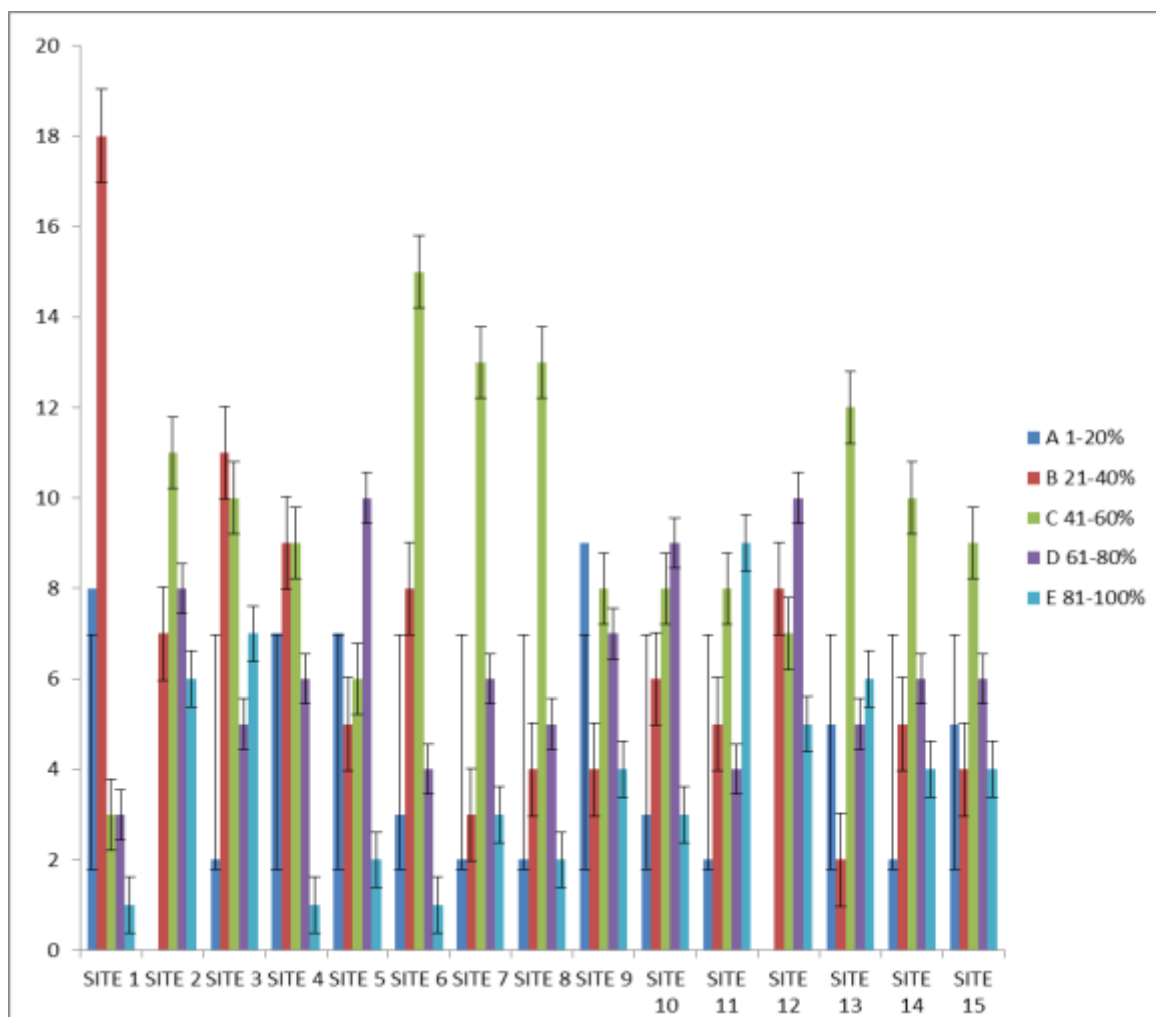


Fig-2 Homogeneity percentage of species in different frequency classes of 15 stands in Balkassar.

References

- Ahmed, A., Khan, S., & Nawaz, Z. (2021). Floristic diversity of Royle forests in Lower Dir, Pakistan: A quantitative approach. *Pakistan Journal of Botany*, 53(1), 221-231.
- Ahmad, K., Khani, Z. I., Ashraf, M., Hussain, M., Ibrahim, M., & Valeem, E. E. (2008). Status of plant diversity at Kufri (Soone Valley) Punjab, Pakistan and prevailing threats. *Pak. J. Bot.*, 40, 993-997.
- Ali, S. I. (2008). The significance of flora with special reference to Pakistan. *Pak. J. Bot.*, 40, 967-971.
- Alvey, A. A. (2006). Promoting and preserving biodiversity in the urban forest. *Urban Forestry & Urban Greening*, 5, 195-201.
- Bergmeier, E. (2002). The vegetation of the high mountains and multivariate analysis. *Phytocoenologia*, 32, 205-249.
- Criddle, R. S., Church, J. N., Smith, B. N., & Hansen, L. D. (2003). Fundamental causes of the global patterns of species range and richness. *Russian Journal of Plant Physiology*, 50, 192-199.
- Frelich, L. E., Calcote, R. R., Davis, M. B., & Pastor, J. (1993). Patch formation and maintenance in an old-growth hemlock-hardwood forest. *Ecology*, 74, 513-527.
- Hussain, A., Mirza, S. N., Khan, I. A., & Naem, M. A. (2009). Determination of relative species composition and seasonal plant communities of Nurpur reserved forest in scrub rangelands of district Chakwal. *Pak. J. Agri. Sci.*, 46, 34-39.
- Hussain, M., Ali, R., & Bashir, R. (2022). Vegetation analysis in Chakwal district: A case study of Nurpur. *Ecological Journal of South Asia*, 10(4), 410-419.
- Khan, A., Hussain, R., & Ahmad, R. (2002). Quality of Ground water in district Chakwal. *Proc. Second South Asia Water Forum*, 14-16 Dec., 2002, Islamabad, Pakistan, 1, 315-320.
- Khan, M. R., Ali, S., & Mahmood, M. (2022). Phytosociological analysis of the Narran Valley vegetation in Pakistan. *Journal of Plant Ecology*, 45(2), 245-256.
- Kilic, M., & Arslan, O. S. (2010). Turkey's Forests and Biodiversity. Workshop on International Symposium on

- Biology of Rare and Endemic Plant Species. (Biorare Symposium) May 26-29.
- Lachowski, H. (1995). Guidelines for the use of digital imagery of vegetation mapping. U.S.D.A. Forest Service, Engineering Staff, Washington D.C., EM-7140-25, 2010, Fethiye-Muğla, Turkey.
- Li, W., Zhang, H., & Sun, J. (2022). Vegetation structure and species diversity of temperate grasslands in northeastern China. *Ecological Research*, 37(3), 531-540.
- Mueller-Dombois, D., & Ellenberg, H. (1974). Aims and methods of vegetation ecology. Wiley & Sons, New York.
- Oosting, H. J. (1956). The Study of Plant Communities (2nd ed.). W. H. Freeman and Co., San Francisco.
- Raunkiaer, C. (1934). The Life Forms of Plants and Statistical Plant Geography. Clarendon Press, Oxford.
- Sharma, P., Rana, J. C., Devi, U., Randhawa, S. S., & Kumar, R. (2014). Floristic diversity and distribution pattern of plant communities along altitudinal gradient in Sangla Valley, Northwest Himalaya. *The Scientific World Journal*, 2014, Article ID 264878, 11 pages.
- Sharma, R., Singh, D., & Mehta, S. (2023). Floral diversity and vegetation patterns in the Sangla Valley, Northwest Himalaya. *Indian Journal of Ecology*, 50(1), 105-118.
- Sorensen, T. (1948). A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. *Det Kong. Danske Videnak. Selk. Biol. Skr.*, 5, 1-5.
- Siddiqui, M. F., Ahmed, M., Shaukat, S. S., & Khan, N. (2010). A quantitative description of moist temperate conifer forests of Himalayan Pakistan and Azad Kashmir. *International Journal of Biology and Biotechnology*, 7, 86-93.
- Stewart, R. R. (1972). An Annotated Catalogue of the Vascular Plants of West Pakistan and Kashmir. Fakhir Printing Press, Karachi, 145-182, 175-185.
- Smith, J., Brown, T., & Green, K. (2019). Advances in plant community analysis and global vegetation mapping. *Global Ecology and Biogeography*, 28(4), 453-468.
- Wang, Z., He, S., & Liu, H. (2017). Vegetation classification and its relationship to climate in global drylands. *Journal of Arid Environments*, 140, 27-34.
- Zhang, J. T. (2004). Quantitative Ecology. Science Press, Beijing. (In Chinese). *Mod. Trad. Chin. Med.*, 10, 86-93.
- Zhang, Z., Li, X., & Liu, L. (2023). Environmental drivers of species distribution and community composition in temperate ecosystems. *Global Ecology and Biogeography*, 32(6), 1115-1130.

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