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Ecological studies of different plant communities of Malasaid Hills, District Bajour, Khyber Pukhtoonkhwa, Pakistan

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Abstract

Ecological evaluation was conducted of the vegetation in Malasaid Hills (Bajaur Agency), Khyber Pakhtonkhwa, Pakistan. Overall, 12 different plant cummunities were recorded in this area. The *Cynodon-Morus-Vitex* (CMV) community had a total of 22 plant species comprising nine herbaceous, 5 shrubby, and 8 tree species. The community was dominated by *Cynodon dactylon*, *Morus alba*, and *Vitex negundo*. The species richness (S.R) of this community was 0.880, similarity index (S.I) 25.80 and maturity index (M.I) 50.37. The *Dodonea-Quercus-Teucrium* (DQT) community comprised a total of 29 plant species. Of these, 11 were herbaceous, 14 shrubby, and 4 tree species. The species richness (S.R) of the community was 1.63, similarity index (S.I) 20.79 and maturity index (M.I) 51.92. The *Berberis-Olea-Ajuga* (BOA) community had a total of 34 plant species comprising 15 herbaceous, 12 shrubby, and 7 trees. The species richness (S.R) of the community was 1.23, similarity index (S.I) 15.38, and maturity index (M.I) 46.94. The *Salvia-Cynodon-Berberis* (SCB) community comprised 16 herbaceous, and 8 shrubby plants, but not a single tree species was found in this community. The species richness (S.R) was 1.31, similarity index (S.I) 33.33 and its maturity index (M.I) 49. The *Cyperus-Calotropis-Ziziphus* (CCZ) community comprised 20 herbaceous, 8 shrubby, and 5 tree species. The species richness (S.R) of the community was 1.14, similarity index (SI) 24.39, and maturity index (M.I) 58.37. The *Juglans-Rumex-Viola* (JRV) community contained 22 herbaceous, 12 shrubby, and 3 tree species. The species richness of this community was 1.45, similarity index 19.17 and maturity index 43.94. The *Reinwardtia-Geranium-Olea* (RGO) community comprised 19 herbaceous, 14 shrubby, and only one tree species. The species richness of this community was 1.60, similarity index 16.49, and maturity index 51.60. The *Rumex-Medicago-Cynodon* community (RMC) had 15 herbaceous, 7 shrubby, and 13 plants as trees. The species richness of this community was 1.31, similarity index 19.75 and maturity index 50.25. The *Duchesnea-Acacia-Neriuum* (DAN) community had 7 herbaceous, 8 shrubby, and 4 plants as tree species with species richness 0.954, similarity index 40, and maturity index 48.33. The *Viola-Berberis-Quercus* (VBQ) community contained 13 herbaceous, 9 shrubby, and 4 tree species. Overall, the communities observed in this area had a different composition.

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Introduction

The name of Bajaur was coined for the area during the Sultanate Period of Dehli, when a ruling

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tribe by the name of" Arab Bajaur" used to exhort taxes and tithes on the produce (Baj) from the local people and then send the same to Delhi (Ali et al., 2017; Aziz et al., 2017). So Baj and Aurdan have been mixed into Bajor or Bajaur. It is one of the seven Agencies, comprising FATA (Federally Administered Tribal Areas), along with the 5 FRS (Frontier Regions) (Ullah et al., 2018). It is bordered by the Kunar province of Afghanistan to its north-west and has a common border of 52 km, starting from the pass of Shahi in the north up to the Nawa pass in the west (Aziz et al., 2017). This border with the Kunar province provides very strategic importance not only to Bajaur, but to Pakistan also. The land mass of the present day Bajaur Agency is actually perched on a slope and gradually tilting and bending downwardly from the Kunar ridge in the direction of Panjkora River in the east (Ullah et al., 2019). Drainage of Bajaur is flowing to the east and this flow starts from the dividing ridge's eastern slopes that overlook the Kunar in Afghanistan. The head quarter of Bajaur Agency is Khar. The distance between Bajaur Agency and Peshawar is 140 km. Bajaur Agency consists mainly of two valleys, viz., Nawagai and Barang (USAID, 1991). These valleys are encircled by hills and mountains of various sizes and shapes, ranging in altitude from above 3000 m.

The site of the current study is an integral part of the Hindu Raj series of the Hindukush range. Bajaur Agency is situated at the North West corner of Pakistan between 34º - 72$^{//}$ to 34º - 74$^{//}$ N latitude 71º- 50$^{//}$ to 71º - 54$^{//}$ E longitude. Bajaur Agency stretches from Munda (Lower Dir) in the east to Nawagai in the west with a length of about 125 km (Ullah et al., 2021). The length of Bajour Agency is about 72 km and the width 40 km. As compared to other Agencies of Federally Administered Tribal (FATA), the area of Bajaur Agency is smaller. These days the total area of Bajaur Agency is only 1290 km^2. The area of Bajaur Agency is fertile. Although some parts of its soil are irrigated by rivers, streams, and tube wells constructed by the government, its large part is arid (Aziz et al., 2017). Most crops (Rabbi and Kharif) are rain-fed and rain cultivated. The land under irrigation in Bajaur is approximately 19,524 ha and the unirrigated area is close to 54,597 ha (Ullah et al., 2019). Major crops are wheat, rice, maize, mustard and barely. The crops of the Rabi season have a very good chance to reach maturity and harvesting stage, but it is a dilemma that due to variation in the timing and amount of precipitation, unpredictable situations are created causing low yield of most crops grown therein.

Some of the rare species of plants of great ethnobotanical and especially of medicinal value are found in the Bajaur agency. A few of these are: Kharawa (*Cotoneaster affinis),* Khar Ghwag (*Verbascum thapsus*), Batoora (*Datura stramonium)*, Maraghoonay (*Solanum surratense)*, Koteelal (*Withania somnifera*), Dambara (*Zanthoxylem armatum*), Markhanai (*Ziziphus mauritiana*), Ghwarija (*Indigofera heterantha*), Khona (*Olea ferruginea*), Inzar (*Ficus palmata),* Palosa (*Acacia modesta*)*,* Gooti (*Ajuga bracteosa*)*,* Ghooz (*Juglans regia*)*, S*eerai (*Quercus incana*)*,* Geeray (*Alnus nitida*)*,* Kwaray (*Berberis lycium*)*,* Spulmai (*Calotropis procera*)*,* Gandiray (*Nerium oleander*)*, S*harghashay (*Saccharum spontaneum*)*,* Nakhtar (*Pinus roxburghii*)*,* Chinar (*Platanus orientalis*), and hundreds of others.

Malasaid is a narrow valley, enclosed from three sides by hills and open at the eastern part, where the area is touched by the plains of Darra. Malasid is divided into two parts, i.e., Lar Malasid, (Lower Malasid), and Bar Malasid (Upper Malasid). Bodi is the first village of Malasid, followed by Chinar Tangay. A deep ravine demarcates the boundary of Lar Malasid and Banda. Bar Malasid comprises Soray, Sar, Ookh, Manzai, Thor gat (Thoor Tham), and Khaza. Khaza touches the Mamund area of Dabar, from where it is accessed by road. The famous village of Salarzai lies at the east of Malasid, and a metal road runs up from there and reaches the top of the hill of upper Malasid. Another road runs up and down from Dabar, a village in Mamund valley and Tehsil. Still another metal road runs up to the Lower Malasid from Darra, to the south of Malasid. In view of the Malasid topography enriched with hills and terrans, different types of plants are found growing sparsely or populously making different types of communities. Thus, this study was undertaken to record the number of communities of the Malasid area and their composition in terms of plant types.

Materials and Methods

Study area

The area of Malasaid Hills (Bajaur Agency) was selected for vegetation surveying and analysis. This area was not selected earlier for ecological evaluation of vegetation. The detailed surveys and vegetation sampling were accomplished in two different seasons. The duration of the Spring season is from March to June, while that of Summer is from July to August. During this period the research area was visited regularly. Collection and preservation of plants were carried out carefully. In this

regard, two types of data in earlier-mentioned seasons were recorded.

Selection of sample sites

For sampling, a total four sites were selected which were further divided into three territories, i.e., foothill, mid-hill and top-hill vegetation based on physiognomy, edaphic factors and altitude. Each site consisted of 48 stands of herbs, shrubs and trees, so overall 12 stands were obtained. To compare the present status of the vegetation with that of past, the local people and elders were nominated and then information gathered from them.

Shape and size of the quadrat

Quadrats of different size according to the vegetation types and cover were selected. They were also based on the habit and physiognomy as well as vegetation type. The different quadrats selected were $1 \times 0.5\ m^2$, $5 \times 10\ m^2$ and $5 \times 20\ m^2$ for herbs, shrubs and trees, respectively. The density, cover and frequency of the plant species were determined.

Selection of sample stands and community attributes

After the projection of all stands in the specific four sites towards North, East, West and South, only those stands were selected which best represented a certain community vegetation and soil profile. After that, the community was nominated based on most abundant species composition, i.e., importance value. The most important attributes of a vegetation community were determined by the following parameters:

Density and relative density

Density (D) is the middling number of a particular species per unit area. It is gained by distributing the whole number of individuals of a specific species in all quadrats by the total area sampled. It was calculated using the following formula:

$$\text{Density (D)} = \frac{Number\ of\ individuals\ of\ a\ species\ present\ in\ a\ quadrat}{Total\ number\ of\ quadrats}$$

Relative density (RD) was obtained by dividing the density of a particular species by the total density of all species multiplying by 100.

$$\text{Relative density (RD)} = \frac{Density\ of\ a\ particular\ species}{\text{Total density for all species in a strand}} \times 100$$

Frequency and relative frequency

Frequency (F) is the percentage of a sample quadrat in which a species exists. It is gained by dividing the number of quadrats in which a particular species appears by total number of quadrats.

$$\text{Frequency (F)} = \frac{Number\ of\ quadrats\ in\ which\ a\ particular\ species\ occurs}{Total\ number\ of\ quadrats\ sampled}$$

Relative frequency (RF) is gained by dividing the frequency of a particular species by the total frequency values of all species in a stand, multiplying by 100.

$$\text{Relative frequency (RF)} = \frac{Frequency\ value\ of\ a\ particular\ species}{Total\ frequency\ values\ for\ all\ species\ in\ a\ stand} \times 100$$

Canopy coverage (C.C) and relative canopy cover

Canopy coverage (C.C) is part of the ground occupied or shaded by a species. It is a vertical projection of crown or shoot area of a species to the ground surface expressed as a fraction or percent of a surface area (Hussain, 1989). For the determination of canopy coverage, Daubenmire's cover scale (Daubenmire, 1959) was applied as given in the below equation. The coverage classes were converted into mid points.

$$\text{Canopy cover (C.C)} = \frac{Sum\ of\ mid\ point\ of\ the\ species}{Total\ canopy\ coverage\ of\ a\ species}$$

Relative canopy cover (R.C.C) is obtained by dividing the canopy cover of a particular species by total-by-total area sampled of canopy cover in a particular stand.

$$\text{Relative canopy cover (R. C. C)} = \frac{Canapy\ cover\ of\ a\ particular\ species}{Total\ cover\ of\ all\ species\ within\ a\ stand} \times 100$$

Basal area

Basal area (BA) is the ground actually penetrated by a crown of a tree. It is a cross section area of a tree as diameter at breast height (DBH), or 1.5 m above the soil. BA was calculated using the following formula:

$$\text{Basal area} = \pi\, r^2$$

$$\text{Where r} = \frac{circumference}{2\pi}$$

$$\text{Basal area (BA)} = \frac{Area\ of\ a\ species\ calculated\ from\ cicumference\ at\ DBH}{Total\ area\ sampled}$$

Relative basal area and importance value

It is obtained by dividing basal area of a specific species by total basal area for all species within a stand, multiplying by 100.

$$\text{Relative Basal area (RBA)} = \frac{Basal\ area\ of\ a\ particular\ species}{Total\ basal\ area\ for\ all\ species\ within\ a\ stand} \times 100$$

It is a very important parameter in ecology based on plant communities established, and the species which have high importance values would be dominant in that stand and the plant community was coined by that species. In a particular stand, importance value can be obtained by adding all the three relative values, i.e., R.D, R.F and R.C.C.

$$\text{Importance value (I.V)} = \text{R.D} + \text{R.F} + \text{R.C.C}$$

Naming of communities and community similarities

Based on the highest importance values of species, the plant communities were named in a specific stand. The name of the species with highest importance value must always leading first, go behind by the second and third one, respectively, of importance value in a descending order. The plant communities always dominated by a single species having high importance value, and the second and third species might have low importance values. During naming the communities, the generic name was used for naming the community, and this was carried out when the number of dominant species were two or three, but a full technical name was used in case of only one dominant species. It is the number of species common to both communities. For the comparison of different stands of a site, community similarity is used. It also shows us percent of the total number of communities. The formula of community similarities is given below. This is also known as Sorensen index (1948) and as follows:

$$\text{IS} = \frac{2C}{A+B} \times 100$$

Where: IS= Index of similarity of Sorensen, C=Number of species common to both communities, A=Total number of species of community A; B=Total number of species of community B.

Species richness and maturity index

Species richness was calculated by a below given formula used by Menhinick (1964). It is expressed as simple ratio between number of species and the square root of the total number of all individuals in a stand.

$$\text{d} = \frac{S}{\sqrt{n}}$$

Where, d= Species richness, S=Total number of species in a stand, N=Total number of individuals in a stand. It was presented by Pichi-Sermollis. It shows the development of a community. Degree of maturity index = $\frac{Ft}{N}$; Where, Ft = All species frequency values in a stand; N = Whole number of species in a position.

Degree of homogeneity and constancy classes

In this method, plants are classified into various frequency classes by using Raunkaier's (1934) Law of frequency. The normal distribution of frequency percentage derived from this classification is

expressed as A>B>C>D>E. Constancy values are always similar to frequency, but having same five classes for different stands.

Regeneration capacity and degree of palatability

Regeneration capacity is the renewable process of vegetation. It shows the community population and age status. Woody plants are classified into different diameter classes by determining it. Each class interval is of 25 cm. Plants (herbs, shrubs and trees) were classified into palatable and non-palatable. The plants used by the cattle were referred to as palatable, whereas those not eaten by the cattle were referred to as non-palatable. It was recorded directly at the spot. Palatable were indicated by +, and non-palatable by the – symbol. Information about palatability was also obtained from local people (herders) and nomads. The plants of the area were classified into the following palatability classes: (1) Non-palatable plants**,** (2) Palatable plants**,** (3) Animal priority. The palatable plants were also classified based on animal grazing preferences such as used by buffalos, cows, sheep or goats.

Phenological study

Phenological proceedings were observed based on which plants were classified into the following three phenological stages: (1) Pre-reproductive stage (Vegetative stage)**,** (2) Reproductive stage (Flowering stage), and (3) Post-reproductive stage (Dormant).

Raunkaierian life form spectrum and leaf size spectrum/leaf categories

Following Raunkaierian (1934) and Hussain (1989) classifications, the plants were classified into the following categories: Class Ⅰ: Phanerophytes, Class Ⅱ: Chaemophytes (CH), Class Ⅲ: Hemicryptophytes (H), Class Ⅳ: Cryptophytes (Cr), Class Ⅵ: Climbers and Lianas, Class Ⅶ: Parasites. There was a consistent variation of leaf size between individual plant communities. Based on Raunkiaer (1934) following classes were categorized:

Leptophyll (L), 25 sq.mm
Nanophyll (N), 9 × 25 sq.mm
Microphyll (M), 9^2 × 25 sq.mm
Mesophyll (Me), 9^3 × 25 sq.mm
Macrophyll (Ma), 9^4 × 25 sq.mm
Megaphyll (Mg), 9^5 × 25 sq.mm

$$\text{Raunkaierian leaf size spectrum} = \frac{\text{Number of species of a particular leaf size class}}{\text{Total number of all species for that stand}}$$

Results and Discussion

Vegetation of Thoortham site: *Cynodon-Morus-Vitex* community (CMV)

This community comprised a total of 22 plants species, and of these, 9 were herbaceous, 5 shrubby and 8 tree species (**Table 1**). The community was dominated by *Cynodon dactylon, Morus alba* and *Vitex negundo*. The species richness (S.R) of this community was 0.880, similarity index (S.I) 25.80 and maturity index (M.I) 50.37 (**Table 12**). First dominant species of this community was *Cynodon dactylon* with importance value (IV) 118.6. It belongs to the family Poaceae and locally known as Bermuda grass or Khabal grass (Noor et al., 2023). *Cynodon dactylon* was found from 600 m elevation and in both sunny and shady places. The second dominant species of this community was *Morus alba* with importance value 103.5. It is locally known as Speen thooth, and it belongs to the family Moraceae (Zhang et al., 2018). It is a fast-growing, small to medium-size tree which grows 15–20 m tall. Usually, its lifespan is short, although some specimens exist with more than 250 years old. The third dominant species of this community was *Vitex negundo* with importance value of 66.9. It is a whitish to greyish tomentose shrub (Gill et al., 2018). It usually occurs from 600-2000 m elevation mostly in dry places. It is locally called Warmandai or Marwandai.

Table 1: *Cynodon-Morus-Vitex* community (CMV)

Herbaceous layer	Number	D	RD	F	RF	CC	RC	IV
Euphorbia hirta L.	50	5	11.82	40	11.42	12.4	11.03	34.28
Cynodon dactylon (L.) Pers.	114	11.4	41.80	90	37.50	19.4	39.35	118.6
Artemisia scorpia Waldst. & Kitam.	12	1.2	4.91	50	6.49	7.4	9.97	11.75
Lathyrus sativus L.	20	2	8.19	60	7.79	7.4	3.92	19.92
Ipomea purpurea (L.) Roth	9	0.9	3.68	60	7.79	12.4	21.82	33.3
Avena sativa L.	20	2	8.19	60	7.79	12.4	3.92	19.92
Cyperus rotundus L.	7	0.7	2.86	50	6.49	7.4	3.49	12.86
Cannabis sativa L.	23	2.3	5.43	20	5.71	7.4	6.58	17.73
Nasturtium officinale R.Br.	16	1.6	5.90	10	4.16	7.4	1.01	11.0
Shrubby layer								
Calotropis procera (Aiton) Dryand.	50	5	11.82	30	8.57	12.4	11.03	31.42
Andrachne cordifolia (Decne.) Pojark	32	3.2	7.56	30	8.57	7.4	6.58	22.72
Vitex negundo L.	57	5.7	20.90	50	20.83	12.4	25.15	66.9
Malvastrum coromandelianum (L.) Garcke	45	4.5	10.63	40	11.42	12.4	11.03	33.09
Nerium oleander L.	48	4.8	11.34	40	11.42	7.4	6.58	29.36
Tree layer						BA	RBA	
Ricinus communis L.	19	1.9	7.78	50	6.49	0.058	0.33	14.62
Tamarix aphylla (L.) H.Karst.	7	0.7	2.86	50	6.49	0.610	3.49	12.86
Eugenia jambolana Lam.	17	1.7	7.37	30	3.89	0.806	4.61	15.99
Juglans regia L.	18	1.8	7.37	30	3.89	0.806	4.61	15.89
Morus alba L.	86	8.6	31.50	90	37.50	2.882	34.48	103.5
Ailanthus altissima (Mill.) Swingle	13	1.3	5.32	40	5.19	1.714	9.82	20.34
Robinia pseudoacacia L.	11	1.1	4.50	40	5.19	1.033	5.92	15.62
Ficus carica L.	27	2.7	11.06	70	9.09	1.109	6.35	26.51

D: Density; RD: Relative density; F: Frequency; RF: Relative frequency; CC: Canopy coverage; RC: Relative canopy cover; IV: Importance value; BA: basal area; RBA: Relative basal area

Dodonaea-Quercus-Teucrium community (DQT)

This community comprised 11 herbaceous, 14 shrubby, and 4 plants tree species (**Table 2**). The community was dominated by *Dodonaea viscosa, Quercus incana* and *Teucrium stocksianum.* The species richness (S.R) of the community was noted as 1.638, similarity index (S.I) 20.79 and maturity index (M.I) 51.92 (**Table 12**). *Dodonaea viscosa* was first dominant species of this community with

Table 2: *Dodonaea-Quercus-Teucrium* community (DQT)

Herbaceous layer	Number	D	RD	F	RF	CC	RC	IV
Cymbopogon schoenanthus (L.) Spreng.	17	1.7	5.29	60	8.69	3.0	3.71	17.70
Cynodon dactylon (L.) Pers.	17	1.7	5.29	40	5.79	3.0	3.71	14.80
Teucrium stocksianum Boiss.	12	1.2	15.78	60	16.66	19.4	2.24	34.71
Trianthema portulacastrum L.	28	2.8	8.72	40	5.79	12.4	15.32	29.86
Oxalis corniculata L.	19	1.9	5.91	40	5.79	7.4	9.15	20.87
Plantago lanceolata L.	27	2.7	8.41	50	7.24	3.0	3.71	19.37
Sonchus oleraceus L.	17	1.7	5.29	30	4.34	3.0	3.71	13.35
Cuscuta reflexa Roxb.	34	3.4	10.59	60	8.69	7.4	9.15	28.44
Thymus linearis Benth.	24	2.4	7.47	50	7.24	7.4	9.15	23.88
Plantago major L.	17	1.7	5.29	30	4.34	3.0	3.71	13.35
Duchesnea indica (Andrews) Teschem.	20	2.0	6.23	70	10.14	12.4	15.3	31.72
Shrubby layer								
Berberis lycium Royle	31	3.1	8.11	70	7.86	17.0	12.34	28.31
Nerium indicum Mill.	27	2.7	7.06	40	4.49	7.4	5.37	16.93
Myrtus communis L.	35	3.5	9.16	80	8.98	12.4	8.99	27.15
Debregeasia salicifolia (D.Don) Rendle	15	1.5	3.92	50	5.61	7.4	5.37	14.91
Hypericum dyeri Rehder	12	1.2	3.14	30	3.37	3.0	2.17	8.69
Hypericum perforatum L.	32	3.2	8.37	60	6.74	7.4	5.37	20.48
Zanthoxylum armatum DC.	11	1.1	2.87	40	4.49	3.0	2.17	9.55
Barleria cristata L.	29	2.9	7.59	70	7.86	12.4	8.99	24.41
Quercus dilatata Lindl.	47	4.7	14.20	40	6.89	0.84	7.21	28.32
Staphylea emodi Brandis	20	2.0	5.23	50	5.61	7.4	5.37	16.24
Indigofera heterantha Wall. ex Brandis	13	1.3	3.40	50	5.61	3.0	2.17	11.16
Dodonaea viscosa Jacq.	15	1.5	19.73	70	19.44	19.4	0.91	40.15
Reinwardtia trigyna (Roxb.) Planch.	11	1.1	2.87	40	4.49	3.0	2.17	9.55

D: Density; RD: Relative density; F: Frequency; RF: Relative frequency; CC: Canopy coverage; RC: Relative canopy cover; IV: Importance value

importance value (I.V) 40.1. It is an ever-green dioecious shrub (Al-Snafi, 2017), normally grow up to 4 m, but sometimes it reaches to a maximum height of 9 m to form a small tree. *Dodonaea viscosa* is dioecious plant, but sometimes it can bear bisexual flowers. *Quercus dialata* is the second dominant plant species of this community with importance value (I.V) 39.85. It belongs to the family Fagaceae (Ahmed et al., 2017) and known as Pirgay or Serai by local people. *Quercus dilatata* is generally found on dry slopes from 1500-3000 m altitude. It is a medium ever-green tree. *Teucrium stocksianum* is the third dominant species of this community based on its importance value (IV) 34.71. Its local name is Khmazoray or Konde Botay. It is an aromatic plant which grows in cluster or tuft form (Imran et al., 2022).

Berberis-Olea-Ajuga community (BOA)

This community had a total of 34 plant species; of these 15 were herbaceous, 12 shrubby, and 7 tree species (**Table 3**). The community was dominated by *Berberis lycium, Olea ferruginea* and *Ajuga bracteosa.* The species richness (S.R) of the community was 1.23, similarity index (S.I) 15.38, and maturity index (M.I) 46.94 (**Table 12**). The first dominant species of this community was *Berberis lycium* with importance value 42.32. Its local name is Kwaray or Ziar Largay. It is an erect or sub-erect ever green shrub (Gupta and Singh, 2018) with 2-5 m long stem. It is found from 100 m to 2900 m elevation. *Olea ferruginea* is the second dominant species of this community which had 41.49 importance value. It belongs to family Oleaceae. Locally it is known as Khunau. It is found from 600-1800 m elevation and occurs commonly on lower hills. It is an evergreen tree or large shrubs up to 5-10 m long (Ali et al., 2019). *Ajuga bracteosa* is the third dominant species of this community which had 36.55 importance value. It is an annual or perennial herb (Kaul et al., 2013) which has a short life span. The stem of *Ajuga bracteosa* is 10-25 cm long spreading or ascending, usually having no branches. The fruit of *Ajuga bracteosa* is known as pale brown “Nutlet” and has prominent ridges.

Table 3: *Berberis-Olea-Ajuga* community (BOA)

Herbaceous layer	Number	D	RD	F	RF	CC	RCC	IV
Polygonum plebeium R.Br.	17	1.7	8.17	60	11.76	3	4.26	24.19
Rumex dentatus L.	20	2	9.61	30	5.88	7.4	10.5	26.01
Carbenia benedicta L.	16	1.6	7.69	50	9.80	3	4.26	21.75
Verbascum thapsus L.	11	1.1	5.28	30	5.88	3	4.26	15.43
Lathyrus sativus L.	20	2	9.61	60	11.76	7.4	10.5	31.89
Thymus linearis Benth.	17	1.7	8.17	40	7.84	7.4	10.5	26.52
Aconitum heterophyllum Wall.ex Royle	11	1.1	5.28	30	5.88	3	4.26	15.43
Ajuga bracteosa Wall. ex Benth.	19	1.9	9.13	50	9.80	12.4	17.6	36.55
Polygonatum verticillatum (L.) All.	3	0.3	1.44	20	3.92	0.5	0.71	6.074
Nasturtium officinale R.Br.	17	1.7	8.17	40	7.84	3	4.26	20.27
Viola canescens Wall.	9	0.9	4.32	40	7.84	0.5	0.71	12.88
Amaranthus viridis L.	17	1.7	5.29	50	7.24	7.4	9.15	21.70
Cuscuta reflexa Roxb.	17	1.7	8.17	10	1.96	7.4	10.5	20.64
Cynodon dactylon (L.) Pers.	20	2	6.75	70	11.6	7.4	7.4	25.82
Anagallis arvensis L.	20	2	6.75	50	8.33	12.4	12.4	27.49
Shrubby layer								
Rabdosia rugosa (Wall. ex Benth.) H.Hara	17	1.7	5.29	50	7.24	7.4	9.15	21.71
Colebrookea oppositifolia Smith	21	2.1	7.09	40	6.66	7.4	7.4	21.16
Olea ferruginea Royle	47	4.7	14.20	80	13.79	-	-	41.49
Dodonaea viscosa Jacq.	43	4.3	14.52	50	8.33	12.4	12.4	35.26
Debregeasia salicifolia (D.Don) Rendle	26	2.6	8.78	40	6.66	7.4	7.4	22.85
Berberis lycium Royle	31	3.1	14.90	50	9.80	12.4	17.6	42.32
Buddleja crispa Benth.	20	2	6.75	70	11.6	7.4	7.4	25.82
Hypericum perforatum L.	22	2.2	7.43	50	8.33	7.4	7.4	23.16
Trachelospermum lucidum K.Schum.	24	2.4	8.11	40	6.66	7.4	7.4	22.17

D: Density; RD: Relative density; F: Frequency; RF: Relative frequency; CC: Canopy coverage; RC: Relative canopy cover; IV: Importance value

Vegetation of Jorgay site: *Salvia-Cynodon-Berberis* community (SCB)

This community had 16 herbaceous and 8 shrubby plant species, but not a single tree species was recorded within this community (**Table 4**). The community was dominated *by Salvia moocroftiana, Cynodon dactylon* and *Berberis lycium.* The species richness (S.R) was 1.310, similarity

index (S.I) 33.33 and maturity index (M.I) 49.0 (**Table 12**). *Salvia moorcroftiana* belonging to Lamiaceae was the first dominant species of this community with IV 56.05. It is a perennial, herbaceous and medicinal plant. It grows up to about 0.92 m long. It is indigenous to the mountains of Himalaya (Khan et al., 2023). It grows between 1100-2900 m elevation on open slopes and disrupted areas. *Salvia moorcroftiana* grows up to about 0.8 m tall. It is used for the treatment of cough and cold, and specifically its seed is used for the treatment of dysentery, piles and bowl pain. The second dominant species was *Cynodon dactylon* with importance value (IV) 118.6. The third dominant species of this community was *Berberis lycium* with importance value 35.39. Its local name is Kwaray or Ziar Largay.

Table 4: *Salvia-Cynodon-Berberis* community (SCB)

Herbaceous layer	Number	D	RD	F	RF	CC	RC	IV
Verbascum thapsus L.	20	2.0	5.50	50	5.95	7.4	5.04	16.5
Cichorium intybus L.	35	3.5	9.64	60	7.14	17.0	11.5	28.3
Cirsium verutum Spreng.	32	3.2	8.81	60	7.14	7.4	5.04	21.0
Salvia moocroftiana Wall. ex Benth.	24	2.4	18.4	50	15.6	17.0	21.9	56.0
Lathyrus sativus L.	29	2.9	7.98	60	7.14	7.4	5.04	20.1
Cirsium falconeri Petr.	33	3.3	9.09	70	8.33	17.0	11.5	29.0
Ajuga bracteosa Wall. ex Benth.	37	3.7	10.1	70	8.33	17.0	11.5	30.1
Echinops cornigerus DC.	32	3.2	8.81	60	7.14	12.4	8.45	24.4
Filago hurdwarica (Wall. ex DC.) Wagenitz	43	4.3	11.8	70	8.33	19.4	13.2	33.4
Cymbopogon schoenanthus (L.) Spreng.	19	1.9	5.23	50	5.95	3.0	2.04	13.2
Cynodon dactylon (L.) Pers.	23	2.3	17.6	40	12.5	7.4	9.56	39.7
Medicago lupulina L.	28	2.8	7.71	50	5.95	12.4	8.45	22.1
Alternanthera pungens Kunth	7	0.7	1.92	50	5.95	7.4	5.04	12.9
Carthamus oxycantha M.Bieb.	9	0.9	2.47	50	5.95	12.4	8.45	16.8
Achyranthes aspera L.	13	1.3	3.58	50	5.95	3.0	2.04	11.5
Viola canescens Wall.	7	0.7	1.92	20	2.38	0.5	0.34	4.6
Shrubby layer								
Viscum cruciatum Sieber ex Bioss.	13	1.3	10.00	40	12.5	7.4	9.56	32.0
Opuntia monacantha (Willd.) Haw.	11	1.1	8.46	40	12.5	3.0	3.87	24.8
Phragmites australis Trin. ex Steud.	15	1.5	11.53	30	9.37	7.4	9.56	30.4
Calotropis procera (Aiton) Dryand.	6	0.6	4.61	30	9.37	3.0	3.87	17.8
Berberis lycium Royle	13	1.3	10.0	30	9.37	12.4	16.0	35.3
Maytenus wallichiana (Sprenge.) D.C.S. Raju & Babu.	35	3.5	9.64	60	7.14	17.0	11.5	28.3
Withania somnifera (L.) Dunal	12	1.2	9.23	30	9.37	7.4	9.56	28.1
Otostegia limbata (Benth.) Boiss.	7	0.7	1.92	50	5.95	7.4	5.04	12.9

D: Density; RD: Relative density; F: Frequency; RF: Relative frequency; CC: Canopy coverage; RC: Relative canopy cover; IV: Importance value

Verbascum-Buddleja-Cotoneaster community (VBC)

There were 10 herbaceous, 8 shrubby, and 5 tree species in this community and it was dominated by *Verbascum thapsus, Buddleja crispa* and *Cotoneaster nummularia* (**Table 5**). The species richness (S.R) of the community was 1.49, similarity index (S.I) 30.18, and maturity index (M.I) 46 (**Table 12**). *Verbascum thapsus* is the first dominant species of this plant community having 80.56 importance value. It is an erect annual or perennial and is about 2 m tall. Locally, this plant is known as Khar Ghwag. It occurs up to 3600 m long altitude, in a wide variety of habitats. It is a medicinal plant, widely used in herbal treatments (Badad et al., 2023). It has emollient and acerbic properties. In topical applications it is used against a variety of skin problems. It is also used to make torches and dyes. *Buddleja crispa* is the second dominant species of this community having 62.61 importance value. It is tomentose shrub locally known as Spera Botay or Spera Panrhay (eFlora of Pakistan; http://www.efloras.org/index.aspx). It is found from 1000-2300 m elevation mostly in sunny and dry places towards south poles. *Cotoneaster nummularia* belonging to family Rosaceae is the third dominant species of this community with IV 57.09. It is locally called Mamanrha. It is an evergreen shrub having 1 m tall rigid scattering branches. It commonly occurs on slopes, rocks and high mountainous areas (Ullah and Badshah, 2023) from 1500-4000 m elevation.

Vegetation of Manzai site: *Cyperus-Calotropis-Ziziphus* community (CCZ)

This community had 20 herbaceous, 8 shrubby, and 5 tree species (**Table 6**). The community is dominated by *Cyperus rotundus, Calotropis procera* and *Cotoneaster nummularia.* Species richness

Table 5: *Verbascum-Buddleja-Cotoneaster* community (VBC)

Herbaceous layer	Number	D	RD	F	RF	CC	RC	IV
Cymbopogon schoenanthus (L.) Spreng.	21	2.1	10.93	50	9.25	7.4	10.48	30.67
Verbascum thapsus L.	33	3.3	30.0	80	28.57	7.4	22.02	80.59
Allium griffithianum Boiss.	17	1.7	8.85	40	7.40	3.0	4.24	20.51
Moraea sisyrinchium (L.) Ker Gawl.	25	2.5	13.02	60	11.11	17.0	24.07	48.21
Ajuga braacteosa Wall. ex Benth.	10	1	5.20	30	5.55	0.5	0.708	11.47
Amaranthus viridis L.	17	1.7	8.85	40	7.40	7.4	10.48	26.74
Chrozophora tinctoria (Linn.) Raffin.	11	1.1	5.72	40	7.40	3.0	4.24	17.38
Cynodon dactylon (L.) Pers.	8	0.8	4.16	40	7.40	0.5	0.708	12.28
Mirabilis jalapa L.	13	1.3	6.77	50	9.25	12.4	17.56	33.59
Ipomoea purpurea (L.) Roth	14	1.4	7.29	50	9.25	3.0	4.24	20.80
Shrubby layer								
Cotoneaster microphyllus Wall. ex Lindl.	15	1.5	13.63	60	21.42	7.4	22.02	57.08
Vitex negundo L.	8	0.8	7.27	10	3.57	3.0	8.92	19.77
Calotropis procera (Aiton) Dryand.	13	1.3	6.77	50	9.25	12.4	17.56	33.59
Opuntia monacantha (Willd.) Haw.	4	0.4	3.63	20	7.14	0.5	1.48	12.26
Phragmites australis (Cav.) Trin. ex Steud.	12	1.2	10.90	30	10.71	7.4	22.02	43.64
Withania somnifera (L.) Dunal	13	1.3	11.81	30	10.71	0.5	1.48	24.02
Buddleja crispa Benth.	25	2.5	22.72	50	17.85	7.4	22.02	62.60
Otostegia limbata (Benth.) Boiss.	25	2.5	13.02	60	11.11	17.0	24.07	48.21
Tree layer						**BA**	**RBA**	
Melia azedarach L.	22	2.2	9.05	70	8.86	2.97	10.98	28.90
Ziziphus jujuba Mill.	15	1.5	6.17	50	6.32	2.55	9.43	21.94
Ailanthus altissima (Mill.) Swingle	11	1.1	4.52	50	6.32	2.45	9.04	19.90
Robinia pseudoacacia L.	8	0.8	3.29	40	5.06	1.63	6.02	14.38
Platanus orientalis L.	11	1.1	4.52	50	6.32	0.74	2.75	13.61

Table 6: *Cyperus-Calotropis-Ziziphus* community (CCZ)

Herbaceous layer	Number	D	RD	F	RF	CC	RC	IV
Solanum surattense Burm.f.	46	4.6	7.05	90	7.69	17.0	8.57	23.32
Fragaria nubicola (Lindl. *ex* Hook.f.) *Lacaita*	27	2.7	4.14	50	4.27	7.4	3.73	12.14
Lathyrus sativus L.	38	3.8	5.83	60	5.12	7.4	3.73	14.68
Achillea millefolium L.	37	3.7	5.67	70	5.98	7.4	3.73	15.38
Anagallis arvensis L.	28	2.8	4.29	60	5.12	12.4	6.25	15.67
Avena sativa L.	12	1.2	1.84	30	2.56	3.0	1.51	5.91
Artemisia santolinifolia Turcz. ex Krasch.	33	3.3	5.06	60	5.12	7.4	3.73	13.9
Cynodon dactylon (L.) Pers.	56	5.6	8.58	90	7.69	19.4	9.78	26.06
Euphorbia hirta L.	25	2.5	3.83	30	2.56	3.0	1.51	7.91
Cyperus rotundus L.	24	2.4	23.5	70	21.8	19.4	26.9	72.36
Xanthium strumarium L.	10	1.0	1.53	20	1.70	0.5	0.25	3.49
Ipomoea purpurea (L.) Roth	33	3.3	5.06	60	5.12	12.4	6.25	16.4
Lathyrus aphaca L.	25	2.5	3.83	60	5.12	7.4	3.73	12.6
Silybum marianum (L.) Graertn	25	2.5	3.83	60	5.12	7.4	3.73	12.6
Capsella bursa-pastoris Medik.	15	1.5	2.30	30	2.56	3.0	1.51	6.37
Centaurea iberica Trev. ex Spreng.	34	3.4	5.21	60	5.12	17	8.57	18.9
Eruca sativa (L.) Mill.	41	4.1	6.28	60	5.12	17	8.57	19.9
Moraea sisyrinchium (L.) Ker Gawl.	27	2.7	4.14	50	4.27	7.4	3.73	12.1
Oxalis corniculata L.	29	2.9	4.44	70	5.98	3.0	1.51	11.9
Salvia moorcroftiana Wall. ex Benth.	57	5.7	8.74	70	5.98	19.4	9.78	24.5
Shrubby layer								
Calotropis procera (Aiton) Dryand.	26	2.6	25.4	60	18.75	12.4	13.6	57.8
Nerium indicum Mill.	51	5.1	14.01	70	10.44	12.4	11.8	36.2
Gymnosporia royleana Wall. ex M.A.Lawson	32	3.2	8.79	70	10.44	7.4	7.06	26.3
Zanthoxylum armatum DC.	23	2.3	6.31	40	5.97	7.4	7.06	19.3
Barleria cristata L.	16	1.6	4.39	40	5.97	3.0	2.86	13.2
Datura stramonium L.	28	2.8	7.69	60	8.95	7.4	7.06	23.7
Staphylea emodi Hedge	17	1.7	4.67	50	7.46	3.0	2.86	14.9
Berberis jaeschkeana C.K.Schneid.	45	4.5	12.3	70	10.4	12.4	11.8	34.6
Debregeasia salicifolia (D.Don) Rendle	17	1.7	4.67	30	4.47	7.4	7.06	16.2
Hypericum dyeri Rehder	14	1.4	3.84	20	2.98	3.0	2.86	9.69
Hypericum perforatum L.	31	3.1	8.51	60	8.95	7.4	7.06	24.5
Ziziphus nummularia (Burm. f.) Wight & Arn.	17	1.7	16.6	70	21.8	12.2	15.18	53.7
Tree layer						**BA**	**RBA**	
Betula utilis D.Don	51	5.1	14.01	80	11.9	1.75	16.22	42.1
Ficus palmata Forssk.	39	3.9	10.71	80	11.9	1.65	16.22	38.8
Quercus dilatata Lindl.	54	5.4	8.28	90	7.69	1.47	9.78	25.7
Pinus roxburghii Sarg.	15	1.5	14.7	60	18.7	0.49	18.41	51.8

D: Density; RD: Relative density; F: Frequency; RF: Relative frequency; CC: Canopy coverage; RC: Relative canopy cover; IV: Importance value; BA: basal area; RBA: Relative basal area

(S.R) of the community was 1.14, similarity index (SI) 24.39 and maturity index (M.I) 58.37 (**Table 12**). The first dominant species of this community was *Cyperus rotundus* having 72.36 importance value. It is a herb (Peerzada, 2017) and may reach up to a height 150 cm. With the importance value 57.85 *Calotropis procera* is the second dominant species of this community. It is locally known as Spalmay. It is called milk weed because the latex it produces is just like milk in colour (Kaur et al., 2021). *Calotropis procera* contains alkaloids which have a strong antimicrobial activity. The third dominant species of the community was *Ziziphus nummularia* with IV 53.73. Locally, it is known as Karkanra. It is a thorny shrub and it has multiple uses as a potential medicinal plant (Mesmar et al., 2022).

Juglans-Rumex-Viola community (JRV)

This community comprises a total of 37 plant species, of which 22 are herbaceous, 12 shrubby, and 3 tree species (**Table 7**). The community was dominated by *Juglans regia, Rumex hastatus,* and *Viola canescens.* The species richness (S.R) of this community was recorded as 1.45, similarity index (S.I) 19.17 and maturity index (M.I) 43.94 (**Table 12**). *Juglans regia* which is locally known as Ghooz is the first dominant plant species of this community having IV 104.8. It was found both wild and cultivated within an elevation of 1000-2800 m. *Juglans regia* is an edible medicinal plant (Bhat et al., 2023). It is used for many purposes. It is valued for its wood and edible fruit. Wood is good for furniture and gun stocks. The bark locally known as "dandasa" is used for mouth and teeth cleanliness. Its seed is rich in oil which is used for cooking. The second dominant species of this plant community was *Rumex hastatus* with 70.84 importance value. It is locally known as Tarrokay or Ghra tarookay. It is a

Table 7: *Juglans-Rumex-Viola* community (JRV)

Herbaceous layer	**Number**	**D**	**RD**	**F**	**RF**	**CC**	**RCC**	**IV**
Geranium ocellatum Jacq. ex Camb.	27	2.7	8.05	80	8.16	7.4	7.84	24.07
Ixiolirion tataricum (Pall.) Herb.	10	1	2.98	30	3.06	0.5	0.53	6.57
Cynodon dactylon (L.) Pers.	16	1.6	4.77	40	4.08	3.0	3.18	12.0
Adiantum venustum D.Don	26	2.6	7.76	60	6.12	7.4	7.84	21.7
Avena sativa L.	10	1	2.98	30	3.06	0.5	0.53	6.57
Bergenia ciliata (Haw.) Sternb.	18	1.8	5.37	60	6.12	3.0	3.18	14.6
Artemisia scoparia Waldst. & Kitam.	14	1.4	4.17	40	4.08	3.0	3.18	11.4
Abutilon fruticosum Guill. & Perr.	15	1.5	4.47	40	4.08	7.4	7.84	16.4
Tulipa clusiana Red.	25	2.5	7.46	70	7.14	12.4	13.15	27.7
Viola canescens Wall.	18	1.8	17.3	40	16.0	19.0	33.86	67.1
Chenopodium album L.	13	1.3	3.88	40	4.08	3.0	3.18	11.1
Limonium cabulicum (Boiss.) Kuntz.	18	1.8	5.37	50	5.10	7.4	7.84	18.3
Salvia moorcruftiana Wall. ex Benth.	20	2	5.97	30	3.06	12.4	13.15	22.1
Polygonatum verticillatum (L.) All.	23	2.3	6.86	90	9.18	3.0	3.18	19.2
Fumaria indica (Hausskn.) Pugsley	13	1.3	3.88	40	4.08	3.0	3.18	11.1
Urtica dioica L.	4	0.4	1.19	20	2.04	0.5	0.53	3.76
Teucrium stocksianum Boiss.	16	1.6	4.77	40	4.08	7.4	7.84	16.7
Origanum vulgare L.	13	1.3	3.88	50	5.10	3.0	3.18	12.1
Amaranthus spinosus L.	5	0.5	1.49	30	3.06	0.5	0.53	5.08
Euphorbia wallichii Hook.f.	12	1.2	3.58	50	5.10	3.0	3.18	11.86
Shrubby layer								
Dodonaea viscosa Jacq.	28	2.8	11.66	50	11.36	12.4	13.40	36.43
Rumex hastatus D.Don	23	2.3	22.11	60	24.0	1.10	24.72	70.84
Periploca aphylla Decne.	8	0.8	3.33	20	4.54	3.0	3.24	11.12
Barleria cristata L.	24	2.4	10.0	40	9.09	0.5	0.54	19.63
Staphylea emodi Wall.	21	2.1	8.75	40	9.09	7.4	8.0	25.84
Indigofera heterantha Wall. ex Brand	15	1.5	6.25	30	6.81	7.4	8.0	21.06
Ziziphus nummularia (Burm.f.) Wight & Arn.	12	1.2	5.0	30	6.81	12.4	13.4	25.22
Maytenus wallichiana (Springe) D.C.S. Raju & Babu	16	1.6	6.66	30	6.81	7.4	8.0	21.48
Berberis lycium Royle	30	3	12.5	50	11.3	12.4	13.4	37.26
Daphne oleoides Schreb.	25	2.5	10.41	30	6.81	7.4	8.0	25.23
Colebrookea oppositifolia Sm.	24	2.4	10.0	40	9.09	7.4	8.0	27.09
Nerium oleander L.	24	2.4	10.0	50	11.3	7.4	8.0	29.36
Tree layer						BA	RBA	
Juglans regia L.	53	5.3	50.9	90	36.0	0.795	17.8	104.8
Platanus orientalis L.	10	1	9.61	60	24.0	1.052	23.5	57.2
Grewia optiva J.R.Drumm. ex Burret.	19	1.9	6.73	70	10.6	0.165	3.57	20.92

D: Density; RD: Relative density; F: Frequency; RF: Relative frequency; CC: Canopy coverage; RC: Relative canopy cover; IV: Importance value; BA: basal area; RBA: Relative basal area

very common bushy, perennial herb or small shrub found up to 3000 m elevation. It is an edible medicinal plant used for many purposes (Qazi et al., 2022). The leaves of *Rumex* contains oxalic acid and tannin. This is also used in leather tanning, while leaves and stems are used as a dye. With importance value of 67.18, *Viola canescens* is the third dominant species of this community. Locally, it is known as "Banafsha". It is a stemless stoloniferous perennial herb. It is found from 950-2700 m elevation in hilly regions. It has high medicinal value (Ahmad et al., 2023).

Reinwardtia-Geranium-Olea community (RGO)

There are 19 herbaceous, 14 shrubby and one tree species in this community (**Table 8**). The community was dominated by *Reinwardtia trigyna, Geranium ocellatum* and *Olea ferruginea*. The species richness (S.R) of the community was 1.60, similarity index (S.I) 16.49, and maturity index (M.I) 51.60 (**Table 12**). *Reinwardtia trigyna* was the first dominant species of this community with highest importance value (34.99). It is locally known as Khaistay. It is a sub-shrub, woody and attractive plant which grows up to 1 m long and is of high medicinal value (Upadhyay et al., 2019). It is found in Himalayas region from 900-2500 m elevation. *Geranium ocellatum* is the second dominant species of this plant community. Its importance value was noted as 31.55. The local name of this plant is Machawonay. It is found from 700-2000 m in hilly areas of the Himalayan region. It is popular for ethnobotanical studies (Alshehri, 2024). *Olea ferruginea* is the third dominant species of this community with IV 27.81. Locally, it is known as Khunau. It is found from 600-1800 m long elevation, but common on lower hills. It is an evergreen tree or large shrub growing up to 5-10 m long. It has high medicinal value (Liaqat et al., 2021).

Table 8: *Reinwardtia-Geranium-Olea* community (RGO)

Herbaceous layer	**Number**	**D**	**RD**	**F**	**RF**	**CC**	**RCC**	**IV**
Malva neglecta Wallr.	28	2.8	5.36	90	8.03	7.4	4.35	17.7
Silybum marianum (L.) Graertn.	33	3.3	6.32	60	5.35	12.4	7.29	18.9
Abutilon fruticosum Guill. & Perr.	28	2.8	5.36	50	4.46	7.4	4.35	14.1
Fragaria nubicola (Lindle. ex Hook.f.) Lacaita	31	3.1	5.93	60	5.35	12.4	7.29	18.5
Tagetes minuta L.	24	2.4	4.59	60	5.35	3.0	1.76	11.7
Boerhavia procumbens Banks ex Roxb.	20	2.0	3.83	60	5.35	3.0	1.76	10.9
Allium griffithianum Boiss.	28	2.8	5.36	50	4.46	12.4	7.29	17.1
Geranium ocellatum Jacq. ex Camb.	49	4.9	10.9	90	11.25	17.0	9.46	31.6
Parthenium hysterophorus L.	31	3.1	5.93	50	4.46	17.0	10.0	20.4
Viola betonicifolia Sm.	31	3.1	5.93	50	4.46	7.4	4.35	14.7
Onosma hispida Wall. ex. G.Don	15	1.5	2.87	30	2.67	3.0	1.76	7.31
Ipomoea purpurea (L.) Roth	34	3.4	6.51	80	7.14	7.4	4.35	18.0
Medicago denticulata Willd.	12	1.2	2.29	30	2.67	3.0	1.76	6.74
Lathyrus aphaca L.	38	3.8	7.27	80	7.14	17.0	10.0	24.4
Achyranthes aspera L.	17	1.7	3.25	40	3.57	3.0	1.76	8.59
Cynodon dactylon (L.) Pers.	40	4.0	7.66	70	6.25	17	10.0	23.9
Artemisia santolinifolia Turcz. ex Krasch.	19	1.9	3.63	70	6.25	7.4	4.35	14.2
Artemisia scoparia Waldst. & Kitam.	32	3.2	6.13	70	6.25	7.4	4.35	16.7
Sonchus asper (L.) Hill	16	1.6	3.06	50	4.46	3.0	1.76	9.29
Shrubby layer								
Hypericum dyeri Rehder	42	4.2	9.37	60	7.5	17.0	9.46	26.3
Hypericum perforatum L.	33	3.3	7.36	50	6.25	12.4	6.90	20.5
Phragmites australis Trin. ex Steud.	10	1.0	2.23	30	3.75	3.0	1.67	7.65
Viscum album Linn.	21	2.1	4.68	50	6.25	7.4	4.12	15.0
Rumex hastatus D.Don	11	1.1	2.45	40	5.0	3.0	1.67	9.12
Reinwardtia trigyna (Rchb.) Plan.	58	5.8	12.9	90	11.25	19.4	10.8	34.9
Datura stramonium L.	25	2.5	5.58	30	3.75	7.4	4.12	13.4
Jasminum humile L.	19	1.9	4.24	40	5.0	7.4	4.12	13.3
Berberis jaeschkeana C.K.Schneid								
Dodonaea viscosa Jacq.	28	2.8	6.25	60	7.5	19.4	10.8	24.5
Ziziphus nummularia (Burm.f.) Wight & Arn.	25	2.5	5.58	50	6.25	12.4	6.90	18.7
Justicia adhatoda L.	29	2.9	6.47	50	6.25	7.4	4.12	16.8
Maytenus wallichiana (Spreng.) D.C.S.Raju & Babu.	26	2.6	5.80	40	5.0	12.4	6.90	17.7
Vitex negundo L.	29	2.9	6.47	50	6.25	17.0	9.46	22.1
Tree layer						BA	RBA	
Olea ferruginea Royle	43	4.3	9.59	70	8.75	1.002	9.46	27.8

D: Density; RD: Relative density; F: Frequency; RF: Relative frequency; CC: Canopy coverage; RC: Relative canopy cover; IV: Importance value; BA: basal area; RBA: Relative basal area

Vegetation of Lar Malasaid site: *Rumex-Medicago-Cynodon* community (RMC)

This community comprises a total of 35 plants species, of which 15 are herbaceous, 7 shrubby, and 13 tree species (**Table 9**). The community is dominated by *Rumex hastatus, Medicago lupulina* and *Cynodon dactylon*. The species richness (S.R) of this community was 1.31, similarity index (S.I) 19.75, maturity index (M.I) 50.25 (**Table 12**). *Rumex hastatus* with IV 42.73 is the first dominant species of this plant community. It is locally known as Tarrokay or Ghra Tarookay. It is a very common bushy, perennial herb or small shrub found up to 3000 m elevation. It is an edible medicinal plant used for many purposes (Ahmad et al., 2019). The leaves of *Rumex hastataus* contains oxalic acid, tannin and a styptic substance. This is also used in leather tanning, while leaves and stems are used as a dye. With 34.54 IV *Medicago lupulina* is the second dominant species of this community. It is locally known as "Marghy Khpa". It is prostrate, pubescent perennial or annual herb and is medicinally very important (Yurkov et al., 2022). It is found from 700-2000 m long elevation. The third dominant species of this community was *Cynodon dactylon* with importance value (IV) 118.6.

Table 9: *Rumex-Medicago-Cynodon* community (RMC)

Name of the species	Number	D	RD	F	RF	CC	RCC	IV
Solanum surattense Burm.f.	17	1.7	5.29	60	8.69	3.0	3.71	17.7
Achyranthes aspera L.	17	1.7	5.29	40	5.79	3.0	3.71	14.8
Solanum nigrum L.	17	1.7	5.29	50	7.24	7.4	9.15	21.7
Tribulus terrestris L.	28	2.8	8.72	40	5.79	12.4	15.3	29.8
Parthenium hysterophorus L.	19	1.9	5.91	40	5.79	7.4	9.15	20.8
Polygonum plebeium R.Br.	22	2.2	6.85	50	7.24	7.4	9.15	23.2
Plantago lanceolata L.	27	2.7	8.41	50	7.24	3.0	3.71	19.3
Silybum marianum (L.) Graertn.	26	2.6	8.09	60	8.69	0.5	0.61	17.4
Taraxacum officinale F.H.Wigg.	17	1.7	5.29	30	4.34	3.0	3.71	13.3
Medicago lupulina L.	32	3.2	10.03	50	7.57	3.0	2.93	34.5
Thymus linearis Benth.	24	2.4	7.47	50	7.24	7.4	9.15	23.8
Avena sativa L.	20	2.0	6.23	30	4.34	3.0	3.71	14.2
Cynodon dactylon (L.) Pers.	20	2.0	6.23	70	10.14	12.4	15.3	31.7
Chenopodium ambrosioides L.	16	1.6	4.98	30	4.34	0.5	0.61	9.95
Shrubby layer								
Myrtus communis L.	21	2.1	6.58	50	7.57	7.4	7.24	21.40
Rumex hastatus D.Don	30	3.0	9.40	60	9.09	7.4	7.24	42.73
Staphylea emodi Wall. ex Brandis	23	2.3	7.21	70	10.6	3.0	2.93	20.75
Indigofera heterantha Wall. ex Brandis	34	3.4	10.65	70	10.6	7.4	7.24	28.50
Nerium oleander L.	20	2.0	6.26	50	7.57	12.4	12.1	25.97
Ziziphus nummularia (Burm.f.) Wight & Arn.	19	1.9	5.95	40	6.06	17.0	16.6	25.65
Maytenus wallichiana (Spreng.) D.C.S.Raju & Babu	20	2.0	6.26	40	6.06	7.4	7.24	19.57
Tree layer						**BA**	**RBA**	
Morus alba L.	19	1.9	6.73	70	10.6	0.165	3.57	20.92
Melia azedarach L.	28	2.8	9.92	60	9.09	0.262	5.67	24.7
Monotheca buxifolia (Falc.) A.DC.	19	1.9	6.73	50	7.57	0.241	5.21	19.52
Eugenia jambos L.	20	2.0	7.09	60	9.09	0.369	7.98	24.17
Juglans regia L.	20	2.0	7.09	40	6.06	0.305	6.60	19.76
Zizyphus oxyphylla Edgew.	23	2.3	8.15	40	6.06	0.715	15.4	21.68
Morus nigra L.	26	2.6	9.21	60	9.09	0.283	6.11	24.43
Ficus carica L.	10	1.0	3.54	30	4.54	0.218	4.72	12.81
Ricinus communis L.	15	1.5	5.31	30	4.54	0.238	5.16	15.02
Tamarix aphylla (L.) H.Karst.	9	0.9	3.19	20	3.03	0.555	12.0	18.23
Quercus dilatata Lindl.	33	3.3	11.7	60	9.09	0.497	10.7	25.54
Diospyros lotus L.	11	1.1	3.90	30	4.54	0.129	2.79	11.24
Ailanthus altissima (Mill.) Swingle	13	1.3	4.60	40	6.06	0.309	6.68	17.36

D: Density; RD: Relative density; F: Frequency; RF: Relative frequency; CC: Canopy coverage; RC: Relative canopy cover; IV: Importance value; BA: basal area; RBA: Relative basal area

Duchesnea-Acacia-Neriuum community (DAN)

This community comprises a total of 19 plants species, of which 7 are herbaceous, 8 shrubby, and 4 tree species (**Table 10**). The community was dominated by *Duchesnea indica, Acacia nilotica* and *Nerium oleander.* The species richness (S.R) was recorded as 0.954, similarity index (S.I) 40.0, and maturity index (M.I) 48.33. *Duchesnea indica* was the first dominant plant species of this community, being highest in IV (97.45). It is locally known as "Balmangai". It is a perennial herb having 25-90 cm long stolon. It is being widely used for treating cancer (Zhu et al., 2015). *Acacia nilotica* attained the

status of second dominant species in this community with 76.65 importance value. Locally, this plant is called Palosa. It is found in dry places up to an elevation of 2400 cm. The third dominant species of this community was *Nerium oleander* having 71.06 importance value. Its medicinal value is significantly high (Sinha and Biswas, 2015).

Viola-Berberis-Quercus community (VBQ)

Thirteen herbaceous, 9 shrubby, and 4 tree species were recorded in this community (**Table 11**).

Table 10: Duchesnea-Acaccia-Nerium community (DAN)

Herbaceous layer	Number	D	RD	F	RF	CC	RC	IV
Verbascum thapsus L.	27	2.7	17.8	90	23.68	12.4	17.22	58.78
Cymbopogon schoenanthus (L.) Spreng.	22	2.2	14.5	50	13.15	12.4	17.22	44.95
Ocimum basilicum L.	13	1.3	8.60	30	7.89	7.4	10.27	26.78
Moraea sisyrinchium (L.) Ker Gawl.	39	3.9	25.8	80	21.0	17.0	23.61	70.49
Duchesnea indica (Andrews) Teschem.	27	2.7	39.7	70	41.1	19.0	16.56	97.45
Chenopodium murale L.	25	2.5	16.5	50	13.1	12.4	17.22	46.93
Ajuga bracteosa Wall. ex Benth.	10	1.0	6.62	40	10.52	3.0	4.16	21.31
Shrubby layer								
Otostegia limbata (Benth.) Boiss.	19	1.9	13.8	60	18.75	12.4	17.27	49.88
Opuntia monacantha (Willd.) Haw.	14	1.4	10.2	30	9.37	7.4	10.30	29.90
Phragmites australis Trin. ex Steud.	24	2.4	17.5	50	15.62	12.4	17.27	50.41
Calotropis procera (Aiton) Dryand.	27	2.7	19.7	60	18.75	12.4	17.27	55.72
Viscum album L.	13	1.3	9.48	40	12.50	7.4	10.30	32.29
Nerium oleander L.	23	2.3	33.8	60	35.29	19.0	7.53	76.65
Barleria cristata L.	28	2.8	20.4	50	15.62	7.4	10.30	46.36
Rumex hastatus D.Don	12	1.2	8.75	30	9.37	12.4	17.27	35.40
Tree layer						**BA**	**RBA**	
Ailanthus altissima (Mill.) Swingle	11	1.1	4.52	50	6.32	2.45	9.04	19.9
Ziziphus jujuba Mill.	11	1.1	16.1	30	17.6	1.24	21.01	54.84
Platanus orientalis L.	11	1.1	4.52	50	6.32	0.74	2.75	13.61
Acacia nilotica (L.) Willd. ex *Delile.*	7	0.7	10.2	10	5.88	3.25	54.87	71.06

Table 11: *Viola-Berberis-Quercus* community (VBQ)

Herbaceous layer	Number	D	RD	F	RF	CC	RCC	IV
Artemisia santolinifolia (Pamp.) Turcz. ex Krasch.	59	5.9	10.51	80	9.87	12.4	12.61	33.0
Aconogonon alpinum (All.) Schur	25	2.5	4.45	40	4.93	3.0	3.05	12.4
Cyperus rotundus L.	9	0.9	1.60	20	2.46	0.5	0.50	4.58
Viola canescens Wall.	72	7.2	25.62	80	16.32	19.4	48.28	90.2
Limonium cabulicum (Boiss.) Kuntze	33	3.3	5.88	40	4.93	7.4	7.52	18.3
Vicia sativa L.	30	3	5.34	40	4.93	7.4	7.52	17.8
Arisaema jacquemontii Blume	26	2.6	4.63	40	4.93	3.0	3.05	12.6
Taraxacum officinale F.H.Wigg.	46	4.6	8.19	60	7.40	7.4	7.52	23.1
Plantago lanceolata L.	13	1.3	2.31	30	3.70	0.5	0.50	6.52
Salvia nubicola Wall. ex Sweet	35	3.5	6.23	60	7.40	12.4	12.6	26.2
Cuscuta reflexa Roxb.	33	3.3	5.88	40	4.93	3.0	3.05	13.8
Achyranthes aspera L.	36	3.6	6.41	50	6.17	3.0	3.05	15.6
Shrubby layer								
Debregeasia salicifolia (D.Don) Rendle	23	2.3	4.17	30	4.34	3.0	2.39	10.9
Nerium indicum Mill.	59	5.9	10.70	70	10.14	12.4	9.90	30.7
Rumex hastatus D.Don	41	4.1	7.44	50	7.24	7.4	5.91	20.5
Daphne mucronata Royle	61	6.1	11.07	70	10.14	7.4	5.91	27.1
Zanthoxylum armatum DC.	13	1.3	2.35	20	2.89	0.50	0.39	5.65
Viscum album L.	14	1.4	2.54	20	2.89	3.0	2.39	7.83
Jasminum humile L.	33	3.3	5.98	60	8.69	12.4	9.90	24.5
Withania somnifera (L.) Dunal	19	1.9	3.44	20	2.89	0.50	0.39	6.74
Calotropis procera (Aiton) Dryand.	44	4.4	7.98	50	7.24	17.0	13.5	28.8
Berberis lycium Royle	73	7.3	13.24	80	11.59	19.4	15.4	40.3
Tree layer						BA	RBA	
Quercus dilatata Lindl.	56	5.6	10.16	90	13.04	1.76	15.49	38.70
Pistacia integerrima J.L.Stewart	17	1.7	6.04	30	6.12	0.37	2.87	15.05
Acacia modesta Wall.	12	1.2	4.27	40	8.16	0.99	7.63	20.07
Celtis caucasica Willd.	19	1.9	6.76	40	8.16	1.14	8.74	23.67

D: Density; RD: Relative density; F: Frequency; RF: Relative frequency; CC: Canopy coverage; RC: Relative canopy cover; IV: Importance value; BA: basal area; RBA: Relative basal area

The community was dominated by *Viola canescens, Berberis lycium* and *Quercus dilatata*. The species richness (S.R) of the community was 1.09, similarity index (S.I) 8.33, and maturity index 48.53. The first dominant species of this community was *Viola canescens* with an importance value 90.23. The second dominant species of this community was *Berberis lycium* with an importance value of 40.33. It is locally known as "Kwaray" or "Ziar Largay". It is an erect or sub-erect evergreen shrub with 2-5 m long stem. All parts such as root, stem, flower and fruit are of great medicinal value. It is commonly found within an elevation of 100-2900 m. *Quercus dilatata* is the third dominant plant species of this community with an IV 39.85. It is vernacularly known as "Pirgay" or "Serai". *Quercus dilatata* is found on dry slopes from 1500-3000 m altitude. It is a medium ever-green tree with considerable medicinal value (Imran et al., 2022).

Table 12: Co-efficient of communities of different stands of Malasaid Hills, Salarzai Bajaur Agency

Plant communities	S.R	S.I	M.I
Cynodon-Morus-Vitex community (CMV)	1.317	19.75	50.25
Dodonaea-Quercus-Teucrium community (DQT)	1.098	8.33	48.53
Viola-Berberis-Quercus community (VBQ)	1.606	16.49	51.60
Salvia-Cynodon-Berberis community (SCB)	1.584	33.33	58.22
Duchesnea-Acacia-Nerium community (DAN)	1.146	24.39	58.37
Verbascum-Buddleja-Cotoneaster community	1.638	20.79	51.92
Cyperus-Calotropis-Ziziphus community (CCZ)	0.880	25.80	50.37
Berberis-Olea-Ajuga community (BOA)	1.236	15.38	46.94
Juglans-Rumex-Viola community (JRV)	1.458	19.17	43.94
Rumex-Medicago-Cynodon community (RMC)	1.499	30.18	46.0
Reinwardtia-Geranium-Olea community	0.954	40.00	48.33
Quercus-Indigofera-Berberis community (QIB)	1.310	33.33	49.0

S.R: Species richness; S.I: Similarity index; M.I: Maturity index

In view of the findings presented here, it is evident that the habitat under examination has unique characteristics because it possesses different plant communities of multifarious nature. However, under the current scenario of climate change, a shift in community composition is expected. Thus, the local population and relevant government bodies need to protect this habitat to keep the community structures and compositions intact.

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This study does not involve human/animal subjects, and thus no ethical approval is required.

Handling of bio-hazardous materials
The authors certify that all experimental materials were handled with great care during collection and experimental procedures. After completion of the study, all materials were properly discarded to minimize/eliminate any types of bio-contamination(s).

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