Impact of Changing Climate on Floristic Composition and Ecological Characteristics of Sheenghar Range, District Karak, Pakistan

Siddiq Ullah[1,2], Fazal Hadi[4]*, Tauseef Ullah[3,*], Fazle Malik Sarim[1] and Fazal Manan[3]
[1]Department of Chemical and Life Sciences, Qurtuba University, Peshawar, Pakistan
[2]Directorate of Non-timber Forest products, Forest Department, KP, Pakistan
[3]Department of Plant Sciences Quaid-i-Azam University, Islamabad, Pakistan
[4]Department of Botany, University of Peshawar, Peshawar, Pakistan
*Correspondence: hadibotany@uop.edu.p; tauseefullah03@gmail.com

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Introduction: This study examines the floristic composition and ecological characteristics of the Sheenghar range hills in District Karak, Pakistan. It aims to highlight the region's biodiversity and explore the impacts of climate change on plant resources.

Novelty Statement: This research is distinguished by its comprehensive floristic inventory and ecological classification of plant species in Sheenghar. It provides valuable insights into how species adapt to climate stress, offering new perspectives on biodiversity in this under-studied region.

Material and Method: Field surveys were conducted to collect and identify plant species in the Sheenghar range. These species were then classified into families and life-forms. The study involved detailed analysis of plant species composition, habitat classification, life-form categories, and leaf size spectra to understand the ecological dynamics of the area.

Results and Discussion: The research identified 185 plant species across 49 families, with Asteraceae being the largest family, comprising 19 species. The area was predominantly herbaceous (65.40%), followed by shrubs (18.91%), trees (14.59%), and parasites (1.08%). Therophytes were the most prevalent life-form class, accounting for 47.45% of the species, while microphylls were the most common leaf size, representing 32.43% of the flora. The findings reveal significant plant diversity but also underscore the severe impact of climate change on the region's flora. The data suggests that while the area supports a variety of species, climate stress poses a significant threat to their survival, indicating a need for further research.

Concluding Remarks: The flora of the Sheenghar range hills is both diverse and vulnerable to the effects of climate change. This underscores the importance of ongoing ecological studies and conservation efforts to safeguard the region's biodiversity and better understand how climate stress impacts plant species.

Keywords: Floristic Composition; Ecological Characteristics; Hilly Regions; Karak; Pakistan.

Introduction:

Flora refers to a comprehensive checklist of plant species within a specific geographic area. Various researchers have investigated the floristic composition across different regions of Pakistan. For instance, Wani and Pant (2022) studied the floristic inventory of District Chakwal and identified Asteraceae and Poaceae as the dominant families [1]. Floristic studies are crucial for understanding species diversity, abundance, environmental management, and ecological dynamics. They provide valuable information about plant species and their classification, which is essential for ecological assessments and rehabilitation efforts following anthropogenic disturbances or natural disasters. Such inventories offer insights into vegetation characteristics [2] [1] [3] and are vital for human well-being, economic health, ecosystem functionality, and stability [4] [5] [6].

The biological spectrum of an area also reflects its climatic conditions, including weather patterns, rainfall, and temperature distribution throughout the year. Long-term climatic conditions contribute to phytogeographic consistency among floristic elements. Life forms of plants are significant indicators of both micro and macroclimates [7]. Plant life forms adapt to climatic conditions, and leaf size spectra, as noted by Oosting (1956), provide insights into the physiological processes governing plants and their communities [8]. Changes in plant life forms and leaf sizes can result from factors such as fire, grazing, and human activities. Malik et al. (2024) highlighted that overgrazing and excessive exploitation of forest resources significantly impact plant life forms [9].

Objectives of the Study:

Present research study was designed with the following objectives.

- To identify and document the plant species present in the study area.
- To determine the ecological features of the plant resources, including family composition, life-form classes, and leaf size spectra.
- To assess the impact of climate change on the flora of the study area.
- To provide a basis for further studies on the flora and species composition of the region under stress conditions.

Materials and Method:

Field Survey of the Research Sites:

Field surveys were conducted between 2018 and 2020, with selected sites visited during two successive seasons: summer and spring. Data were meticulously recorded in a field notebook, and photographs of the sites were taken as shown in Figure 2.

Field Work Tools:

Before plant collection, general and essential data about the research sites were gathered. The following tools were used during plant collection: compass, field diary, pencil, tag pad, tissue roll, zipper bags, forceps, rubber bands, insect repellent spray, trowel, cutter, metal snips, knife, and camera. GPS coordinates of the research sites were recorded using a GPS Etrex-10 device.

Plant Collection, Preservation, and Identification:

Plants were collected from various locations within the study area and identified using the "Flora of Pakistan" [10] [11]. An alphabetical floristic list of species, including families and ecological descriptions, was compiled. Life forms and leaf size classes were classified following Raunkiaer (1934) [12]. Collected specimens were dried and preserved using standard methods. Each specimen was assigned a voucher number and deposited in the Department of Life and Chemical Sciences at Qurtuba University.

Results:

The flora of the Sheenghar Ranges comprises 185 plant species across 49 families. The Poaceae family was the largest, with 27 species, followed by Asteraceae with 19 species, Papilionaceae with 13 species, and Brassicaceae with 9 species. Other prominent families

included Solanaceae, Chenopodiaceae, Cucurbitaceae, and Lamiaceae, each with 7 species. Additionally, Amaranthaceae had 6 species, while Boraginaceae and Euphorbiaceae each had 5 species, and Mimosaceae and Moraceae each had 4 species. Other families contained 3 or fewer plant species, as illustrated in Figure 4.

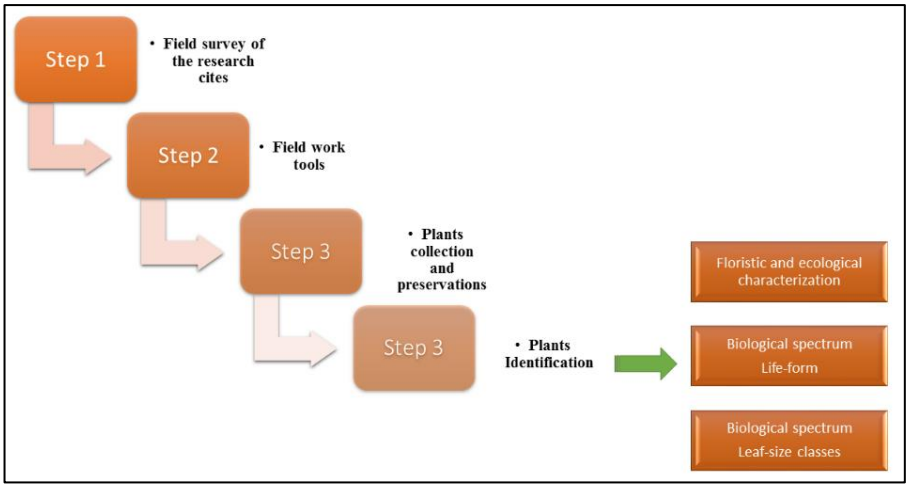

Figure 1: Chart showing research methodology.

Figure 2: Natural view of different sites, Sheenghar Range hills, district Karak, KP, Pakistan (Photoes taken by Tauseef Ullah).

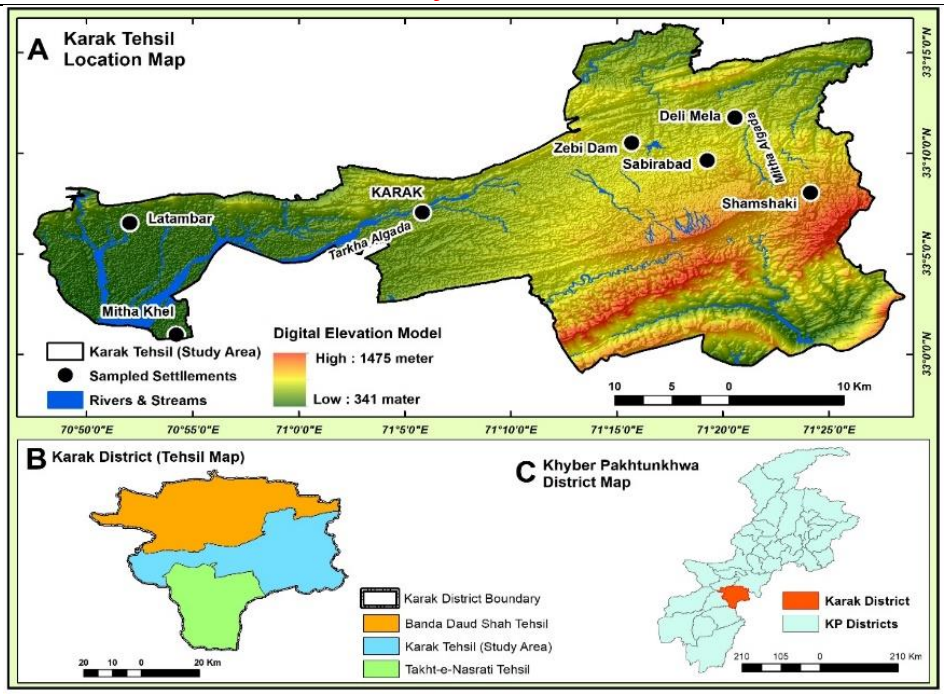

Figure 3: Research area map showing different sampling sites.

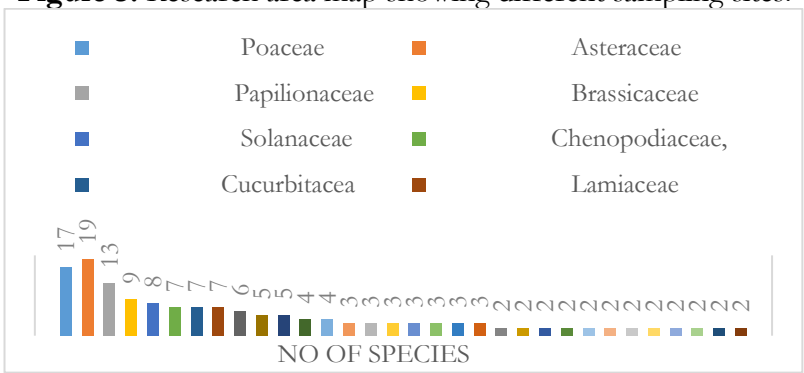

Figure 4: Leading Plant families with reference to species diversity in the research area.

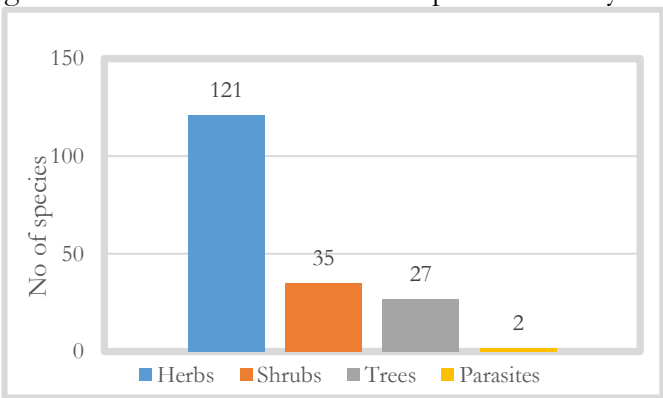

Figure 5: Plant stratification in Sheenghar ranges, District Karak, Khyber Pakhtunkhwa, Pakistan.

Ecological features of the Flora.

Based on plant habit, the area is predominantly characterized by herbs, which make up 65.40% of the flora, followed by shrubs at 18.91% and trees at 14.59%. The proportion of parasites is notably low, at just 1.08% (see Figure 5). Among the flora, 155 species (83.78%) are spineless. In terms of light requirements, 182 species (98.37%) are heliophytes, thriving in full sunlight, while only 3 species (1.62%) are sociophytes, which prefer shaded conditions. The

habitat analysis reveals that 178 species are terrestrial. Regarding leaf structure, 149 species (79.66%) have simple leaves, 17.83% have compound leaves, and 1.62% are aphyllous, meaning they lack leaves. The prevalence of aphyllous species is a characteristic feature of arid and severe environments.

Biological Spectrum:

Raunkiaer Life form Classification:

The biological spectrum of the Sheenghar hills reveals that therophytes are the dominant life-form, comprising 47.45% of the flora. This is followed by hemicryptophytes at 12.99%, megaphanerophytes at 12.97%, nanophanerophytes at 9.60%, and geophytes at 3.95% (see Figures 6 and 7). Detailed descriptions of these life-form categories are provided in Table 1.

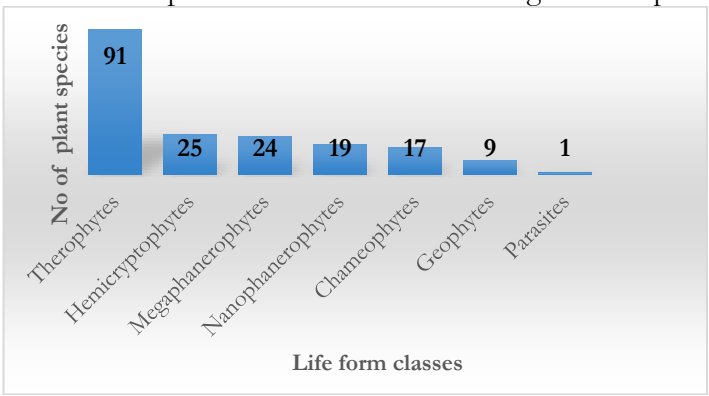

Figure 6: Biological range of the Sheenghar ranges hills of the study area.

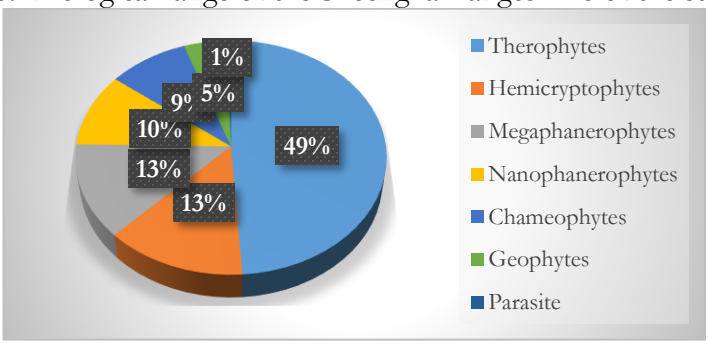

Figure 7: Percentage distribution of Life form classes of the research area vegetation.

Raunkiaer Life Size Classification:

The leaf size spectrum of the study area shows that microphylls are the most prevalent, representing 32.43% of the species. They are followed by nanophylls at 27.56%, leptophylls at 18.91%, and mesophylls at 18.37%. Aphyllous species account for 1.62%, while megaphylls constitute the smallest proportion at 0.54% (see Figures 8 and 9).

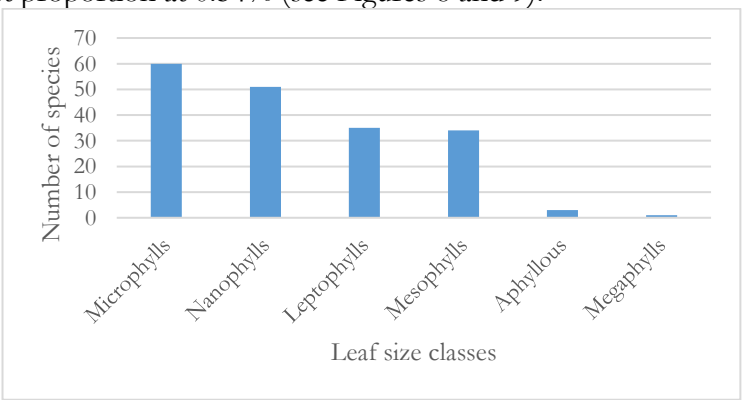

Figure 8: Leaf size spectrum of the plants in the research area.

Table 1: Floristic inventory and ecological characteristics of plants of Sheenghar Ranges, Karak, KP, Pakistan.

S.no	Plant Botanical name	Family	Habit	Habitat	Life form	Leaf size	Leaf shape	Light demand	Spinescence
1	*Allium cepa* L.	**Alliaceae**	H	Te	Geo	Nan	S	He	-
2	*Allium sativum* L.	-	H	_	Geo	Nan	S	He	-
3	*Aloe barbadensis* Mill.	**Aloaceae**	H	_	Np	Mes	S	He	+
4	*Nannorrhops ritchiana* (Griff.) Aitchison	**Arecaceae**	Sh	_	Np	Meg	S	He	-
5	*Phoenix dactylifera* L.	-	T	_	Ch	Mic	C	He	+
6	*Asparagus adscendens* Roxb.	**Asparagaceae**	H	_	Ch	Mic	S	He	-
7	*Asparagus gracilis* Royle.	-	H	_	Th	Lep	S	He	-
8	*Cyperus rotundus* L.	**Cyperaceae**	H	_	Hem	Th	S	He	-
9	*Cyperus niveus* Retz., Observ.	-	H	_	Hem	Th	S	He	-
10	*Juncus inflexus* Linn.	**Juncaceae**	H	Aq	Geo	Lep	S	He	-
11	*Aristida adscensionis* Linn.	**Poaceae**	H	Te	Hem	Mic	S	He	-
12	*Avena fatua* Linn	-	H	_	Nan	S	He	He	-
13	*Avena sativa* L.	-	H	_	Th	Nan	S	He	-
14	*Cenchrus biflorus* Hook. f.	-	H	_	Hem	Lep	S	He	-
15	*Cenchrus setigerus* Linn.	-	H	_	Hem	Lep	S	He	-
16	*Cenchrus ciliaris* Linn.	-	H	_	Hem	Lep	S	He	-
17	*Cymbopogon jwarancus* (Jones) Schult.	-	H	_	Hem	Nan	S	He	-
18	*Cynodon dactylon* (L) Pres.	-	H	_	Hem	Lep	S	He	-
19	*Dactyloctenium aegyptium* (L.) Willd.	-	H	_	Th	Mic	S	He	-
20	*Desmostachya bipinnata* (L.) Stapf.	-	H	_	Hem	Nan	S	He	-
21	*Dichanthium annulatum* (Forssk.) Stapf	-	H	_	Hem	Nan	S	He	-
22	*Echinochloa colona* (L.) Link.	-	H	_	Th	Mic	S	He	-
23	*Eleusine compressa* (Forssk.)	-	H	_	Hem	Nan	S	He	-
24	*Eleusine indica* (Linn.) Gaertn.	-	H	_	Hem	Nan	S	He	-
25	*Eragrostis poaoides* Beauv.	-	H	_	Th	Nan	S	He	-
26	*Eragrostis minor* Host.	-	H	_	Th	Nan	S	He	-
27	*Imperata cylindrica* (Linn.) Raeuschel.	-	H	_	Th	Lep	S	He	-
28	*Pennisetum orientale* L. C. Rich.	-	H	_	Hem	Nan	S	He	-
29	*Poa annua* Linn.	-	H	_	Th	Nan	S	He	-
30	*Poa infirma* H. B. K.	-	H	_	Th	Mic	S	He	-
31	*Polypoon monspeliensis* Linn.	-	H	_	Th	Nan	S	He	-
32	*Saccharum bengalense* Retz	-	Sh	_	Che	Meso	S	He	-
33	*Saccharum spontaneum* L.	-	Sh	_	Che	Meso	S	He	-
34	*Sorghum vulgare* (L.) Pers.	-	H	_	Hem	Mic	S	He	-
35	*Setaria viridis* (Linn.) P. Beauv.	-	H	_	Th	Mic	S	He	-
36	*Triticum aestivum* L.	-	H	_	Th	Mic	S	He	-
37	*Zea mays* L.	-	H	_	Th	Mes	S	He	-
38	*Achyranthes aspera* L.	**Amaranthaceae**	H	_	Th	Nan	S	He	+
39	*Amaranthus graecizans* Linn.	-	H	_	Th	Lep	S	He	-
40	*Amaranthus spinosus* Linn.	-	H	_	Th	Nan	S	He	+
41	*Amaranthus viridis* L.	-	H	_	Th	Nan	S	He	-
42	*Digera muricata* (L.) Mart.	-	H	_	Th	Mic	S	He	-
43	*Pupalia lappacea* (L.) Juss.	-	H	_	Th	Mic	S	He	+
44	*Mangifera indica* L.	**Anacardiaceae**	T	_	Mp	Mes	C	He	-
45	*Asphadelus tunifolius* Cavan.	**Asphodelaceae**	H	_	Geo	Lep	S	He	-
46	*Coriandrum sativum* L.	**Apiaceae**	H	_	Th	Lep	C	He	-
47	*Daucus carrota* L.	-	H	_	Th	Lep	C	He	-
48	*Torilis leptophylla* (L.) Reichb. f.	-	H	_	Th	Lep	C	He	-
49	*Rhazya stricta* Dcne.	**Apocynaceae**	Sh	_	Che	Mic	S	He	-

50	*Nerium indica* Mill.	-	Sh	_	Mic	Nan	S	He	-
51	*Calotropis procera* (Wild) R. Br.	**Asclepiadaceae**	Sh	_	Che	Mes	S	He	-
52	*Periploca aphylla* Decne.	-	Sh	_	Np	Ap	Absent	He	-
53	*Carthamus tinctorius* L.	**Asteraceae**	H	_	Th	Nan	S	He	+
54	*Calendula arvensis* L.	-	H	_	Th	Nan	S	He	-
55	*Carthamus oxycantha* Bieb	-	H	_	Th	Mic	S	He	+
56	*Centaurea iberica* Trevir. ex. spreng.	-	H	_	Th	Nan	S	He	+
57	*Conyza canadensis* (Linn.) Cronq.	-	H	_	Th	Lep	S	He	-
58	*Echinops echinatus* D. C	-	H	_	Th	Mic	S	He	+
59	*Gnaphalium affine* D. Don	-	H	_	Hem	Mic	S	He	-
60	*Helianthus annus* L.	-	H	_	Th	Mes	S	He	-
61	*Hertia intermedia* (Boiss.) O. Ktze.	-	H	_	Che	Lep	S	He	-
62	*Inula grantioides* Boiss.	-	H	_	Th	Nan	S	He	-
63	*Lactuca sativa* L.	-	H	_	Th	Nan	S	He	-
64	*Lactuca serriole* L.	-	H	_	Th	Nan	S	He	-
65	*Launaea procumbens* (Roxb.) Boiss	-	H	_	Th	Mes	S	He	-
66	*Paulicaria glaucescens* (Bois.) Jaub	-	Sh	_	Np	Lep	S	He	-
67	*Pluchea arguta* Boiss.	-	Sh	_	Np	Mic	S	He	-
68	*Saussurea heteromalla* (D. Don) Hand.	-	H	_	Th	Mic	S	He	-
69	*Sonchus asper* (L.) Hill.	-	H	_	Th	Mic	S	He	-
70	*Taraxacum officinale* Webber.	-	H	_	Th	Mic	S	Aq	-
71	*Xanthium strumarium* L.	-	H	_	Th	Nan	S	He	+
72	*Arnebia griffithii* Boiss.	**Boraginaceae**	H	_	Th	Mic	S	He	-
73	*Cordia myxa* L.	-	T	_	Mp	Mes	S	He	-
74	*Heliotropium europaeum* L.	-	H	_	Th	Mic	S	He	-
75	*Heliotropium strigosum* Willd.	-	H	_	Th	Mic	S	He	-
76	*Onosma hispida* Wall.	-	H	_	Hem	Mic	S	He	+
77	*Brassica campestris* Linn.	**Brassicaceae**	H	_	Th	Mic	S	He	-
78	*Brassica napus* L.	-	H	_	Th	Mes	S	He	-
79	*Brassica repa* L.	-	H	_	Th	Nan	S	He	-
80	*Brassica oleraceae* Linn.	-	H	_	Th	Nan	S	Aq	-
81	*Coronopus didymus* (L)	-	H	_	Th	Mic	C	He	-
82	*Malcolmia africana* (L) R. Br.	-	H	_	Th	Nan	S	He	-
83	*Malcolmia strigosa* Boiss.	-	H	_	Th	Mic	S	He	-
84	*Raphanus sativus* L.	-	H	_	Th	Mes	S	He	-
85	*Sissymbrium irrio* L.	-	H	_	Th	Nan	S	Aq	-
86	*Capoaris decidua* (Forssk). Edgeworth.	**Capparidiaceae**	T	_	Mp	Ap	absent	He	+
87	*Capparis spinosa* L.	-	Sh	_	Che	Mic	S	He	+
88	*Cleome viscosa* L.	-	H	_	Th	Mic	C	He	-
89	*Maytenus royleanus* Wall.	**Celastraceae**	Sh	_	Np	Mic	S	He	+
90	*Atriplex lasiantha* Boiss.	**Chenopodiaceae**	H	_	Th	Mic	S	He	-
91	*Chenopodium album* L.	-	H	_	Th	Nan	S	He	-
92	*Chenopodium murale* L.	-	H	_	Th	Lep	S	He	-
93	*Kochia prostrate* (L) Schrad	-	H	_	Np	Nan	S	He	-
94	*Spinaceae olaraceae* L.	-	H	_	Th	Mic	S	He	-
95	*Suaeda fruticosa* Forssk	-	H	_	Che	Lep	S	Salted	-
96	*Haloxylon griffithii* Moq	-	Sh	_	Th	Meso	S	He	-
97	*Convolvulus arvensis* L.	**Convolvulaceae**	H	_	Th	Nan	S	He	-
98	*Convolvulus prostratus* Forssok	-	H	_	Th	Lep	S	He	-
99	*Citrullus colocynthis* L. Schrad.	**Cucurbitaceae**	H	_	Th	Mic	S	He	-
100	*Citrullus vulgaris* Schrad ex Eckl. & Zeyh	-	H	_	Th	Meso	S	He	-
101	*Cucumis melo* Linn.	-	H	_	The	Meso	S	He	-

102	*Cucurbita pepo* L.	-	H	_	The	Meso	S	He	-
103	*Luffa aegyptica* (L) M. J. Rocm	-	H	_	The	Meso	S	He	-
104	*Luffa cylindrical* (L) Roem.	-	H	_	The	Meso	S	He	-
105	*Momordica charantia* Linn.	-	H	_	The	Meso	S	He	-
106	*Cuscuta reflexa* Roxb.	**Cuscutaceae**	P	_	Th	Ap	S	He	-
107	*Euphorbia granulate* Forssk.	**Euphorbiaceae**	H	_	Hem	Lep	C	He	-
108	*Euphorbia helioscopia* L.	-	H	_	Th	Nan	C	He	-
109	*Euphorbia prostrata* L.	-	H	_	Th	Lep	C	He	-
110	*Euphorbia hypericifolia* L.	-	H	_	Th	Lep	C	He	-
111	*Ricinus communis* L.	-	Sh	_	Hem	Meso	S	He	-
112	*Fumaria indica* (Haussk.) Pugsley	**Fumaraceae**	H	_	Th	Nan	S	He	-
113	*Ajuga bracteosa* Wall. Ex. Benth	**Lamiaceae**	H	_	Hem	Mic	S	He	-
114	*Mentha arvensis* L.	-	H	_	Hem	Mic	S	Sc	-
115	*Mentha longifolia* (L.)	-	H	_	Hem	Mic	S	Sc	-
116	*Ocimum basilicum* L.	-	Sh	_	Chem	Nano	S	Sc	-
117	*Otostegia limbata* (Benth.) Boiss.	-	Sh	_	Np	Mic	S	He	+
118	*Salvia aegyptica* L.	-	H	_	Th	Mic	S	He	-
119	*Salvia moorcroftiana* Wallich ex Benth.	-	H	_	Th	Meso	S	He	-
120	*Salvia santolinifolia* Boiss. Diagn.	-	H	_	Th	Nan	S	He	-
121	*Abutilon bidentatum* A. Rich.	**Malvaceae**	Sh	_	Chem	Nan	S	He	-
122	*Abutilon indicum* (Linn.) Sweet.	-	H	_	Th	Nan	S	He	-
123	*Malva parviflora* L.	-	H	_	Th	Mic	S	He	-
124	*Melia azedarach* L.	**Meliaceae**	T	_	Mp	Nan	C	He	-
125	*Tinospora cordifolii* (DC.)Sweet.	**Menispermaceae**	Sh	_	Mac	Lep	S	He	-
126	*Acacia modesta* Wall.	**Mimosaceae**	T	_	Mp	Lep	C	He	+
127	*Acacia nilotica* (L.) Delice.	-	T	_	Mp	Lep	C	He	+
128	*Albizia lebbeck* (L.) Benth.	-	T	_	Mp	Lep	C	He	-
129	*Prosopis juliflora* (Sw.) DC.	-	T	_	Mp	Lep	C	He	+
130	*Ficus palmata* Forssk.	**Moraceae**	T	_	Np	Mes	S	He	-
131	*Ficus carica* L.	-	T	_	Np	Mes	S	He	-
132	*Morus alba* L.	-	T	_	Np	Mes	S	He	-
133	*Morus nigra* L.	-	T	_	Np	Mes	S	He	-
134	*Eucalyptus globules* L.	**Myrataceae**	T	_	Mp	Nan	S	He	-
135	*Eualyptus lanceolatus* L.	-	T	_	Mp	Nan	S	He	-
136	*Boerhavia procumbens* Bank ex Roxeb	**Nyctaginaceae**	H	_	Hem	Nan	S	He	-
137	*Marabilis jalapa* Linn.	-	H	_	Chem	Meso	S	He	-
138	*Jasminum officinale* Linn.	**Oleaceae**	Sh	_	Np	Mic	C	He	-
139	*Jasminum humile* Linn.	-	Sh	_	Np	Mic	C	He	-
140	*Olea ferruginea* Royle.	-	T	_	Mp	Mic	S	He	-
141	*Orobanche ramose* L.	**Orobanchaceae**	P	_	Np	Nan	A	He	-
142	*Cistanche tubulosa* (Schrenk.) Hook. f.	-	H	_	Th	Nan	S	He	-
143	*Oxalis corniculata* L.	**Oxalidaceae**	H	_	Th	Nan	C	He	-
144	*Alhagi maurorum* Medik.	**Papilionaceae**	Sh	_	Hemo	Meso	S	He	-
145	*Arachis hypogaea* L.	-	H	_	Th	Mic	S	He	-
146	*Astragalus amherstianus* Royle ex Benth	-	Sh	_	Chem	Lep	S	He	+
147	*Astragalus psilocentros* Fisch.	-	H	_	Chem	Lep	S	He	+
148	*Cicer arietinum* L.	-	H	_	Th	Lep	C	He	-
149	*Dalbergia sisso* Roxb.	-	T	_	Mp	Mic	C	He	-
150	*Lathyrus aphaca* Linn.	-	H	_	Th	Nan	S	He	-
151	*Lespedeza juncea* Linn.	-	Sh	_	Nan	Chem	S	He	-
152	*Medicago laciniata* L.	-	H	_	Th	Nan	C	He	-

153	*Midicago polymorpha* Linn.	-	H	_	Th	Nan	C	He	-
154	*Melilotus indicus* L.	-	H	_	Th	Nan	C	He	-
155	*Trionella incise* Boiss.	-	H	_	Th	Nan	S	He	-
156	*Vicia sativa* L.	-	H	_	Th	Nan	C	He	-
157	*Punica granatum* L.	**Punicaceae**	T	_	Mp	Mic	S	He	+
158	*Ranunculus arvensis* L.	**Ranunculaceae**	H	_	Th	Mic	S	He	-
159	*Ranunculus murathus* L.	-	H	_	Geo	Mic	S	He	-
160	*Zizyphus maurtiana* Linn.	**Rhamnaceae**	T	_	Mp	Mic	S	He	+
161	*Zizyphus nummularia* (Burm.f)	-	T	_	Np	Mic	S	He	+
162	*Zizyphus oxyphylla* Edgew	-	T	_	Np	Mic	S	He	+
163	*Eriobotrya japonica* (Thunb).	**Rosaceae**	T	_	Mp	Meso	S	He	-
164	*Prunus armeniaca* L.	-	T	_	Mp	Mic	S	He	-
165	*Rosa indica* L.	-	Sh	_	Np	Mic	C	Sc	+
166	*Salvadora oleoides* Decne.	**Salvadoraceae**	T	_	Np	Mic	S	He	-
167	*Dodonaea viscosa* L.	**Sapindaceae**	Sh	_	Np	Mic	S	He	-
168	*Monotheca buxifolia* (falk) Linn	**Sapotaceae**	T	_	Mp	Mic	S	He	+
169	*Kickxia ramosissima* (Wall) Jan.	**Scrophulariaceae**	H	_	Hemo	Nano	S	He	-
170	*Verbascum thapsus* Linn.	-	H	_	The	Meso	S	He	-
171	*Ailanthus altissima* Mill.	**Simaroubaceae**	T	_	Mp	Meso	S	He	-
172	*Datura metel* L.	**Solanaceae**	Sh	_	Np	Meso	S	He	-
173	*Lycopersicum esculentum* L.	-	H	_	Th	Mic	S	He	-
174	*Solanum incanum* L.	-	Sh	_	Chem	Meso	S	He	+
175	*Solanum melongena* L.	-	H	_	Th	Meso	S	He	-
176	*Solanum nigrum* L.	-	H	_	Th	Mic	S	He	-
177	*Solanum surattense* Burm. f.	-	H	_	Hemo	Meso	S	He	+
178	*Withania coagulans* Dunal.	-	Sh	_	Chem	Mic	S	He	-
179	*Withania somnifera* L.	-	Sh	_	Chem	Mic	S	He	-
180	*Tamarix aphylla* (L.) Karst.	**Tamaricaceae**	T	_	Mp	Lep	S	He	-
181	*Vitex negundo* L.	**Verbenaceae**	Sh	_	Np	Mic	C	He	-
182	*Vitex trifolia* L.	-	Sh	_	Np	Mic	C	He	-
183	*Fagonia cretica* L.	**Zygophylaceae**	H	_	Th	Lep	S	He	+
184	*Peganum harmala* L.	-	H	_	Hem	Lep	C	He	-
185	*Tribulus pentandrus* Forsk.	-	H	_	Hem	Lep	C	He	+

Key: Th = Therophyte; Ch = Chamaephyte; Np = Nanophanerophyte; Mp = Microphanerophyte; Nanophyll; Mes = Mesophyll; Meg = Megaphyll; Lp = Leptophyll; Mic; Microphyll; Ap = Aphyllous; Geo; Geophyte; Hem = Hemicryptophyte; P = Parasite, S = Simple; C = Compound; He; Helophyte; Sp = Spiny; Ns = Not spiny; H = Herb; S = Shrub; T = Tree: Te; Terrestrial; Aq = Aqueous; S: Salted

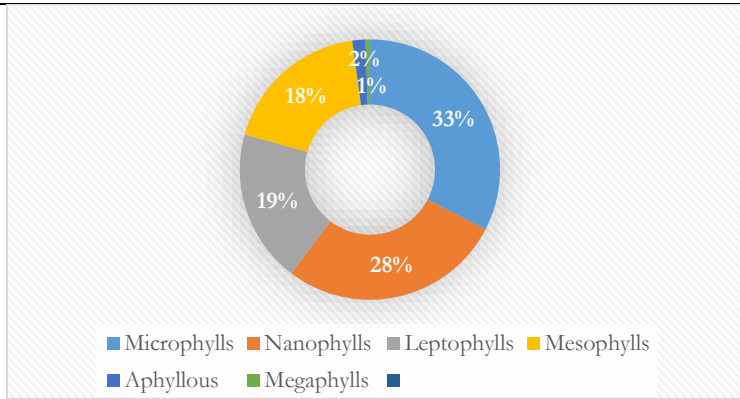

Figure 9: Percentage wise distribution of leaf size classes of flora in the area.

Discussions:

Floristic study is important for the diversity, abundance of species, environment management, and ecological studies. Flora of any area provides useful information about plants. Identification and classification of floristic components of any area are also vital for ecological purposes and rehabilitation after destruction by anthropogenic activities or natural disasters [13]. In the present study, the family Asteraceae was found to be dominant in the area with 19 species. Our results align with the findings of Khan et al. [14], which showed that Poaceae and Asteraceae were the leading families in the Noshpho salt mines region in Karak. Our results are also consistent with studies by Anwar et al., Rashid et al., and Javid et al. [15][16][17]. Due to human activity and the region's arid climate, the dominance of therophyte plants indicates that the area is under extreme biotic pressure. According to the current study, the harsh and xeric conditions in the area are reflected in the predominance of therophytes. Our findings are supported by studies from different regions of the world [5][4][18][19]. Additionally, biological spectra are used to assess life forms and leaf sizes to better interpret the climatic conditions of an ecosystem. These physiological traits serve as markers for biotic interactions and changes in the climate and ecosystem. Climate conditions tend to be similar across diverse places with similar biological spectra. Raunkiaer (1934) asserted that an area's biological spectrum and life forms define its climate and habitat, while biological disturbances can alter the balance of different life forms [13].

The predominance of therophytes indicates that the research region is subject to intense biotic and anthropogenic pressure, such as grazing pressure and human disturbance [17][20]. Consequently, hemicryptophytes are less able to survive in this environment. Our findings align with those of Khan et al. and Haq et al. [12][20], who reported therophytes as the dominant life form spectra due to various environmental gradients in the hills of District Kotli, AJK, Pakistan. Similarly, Sharma and Raina reported that therophytes were the

predominant vegetation in their study regions, along with hemicryptophytes and megaphanerophytes [22][23][13]. In the present study area, nanophylls and microphylls were found to be the predominant leaf size classes. Similarly, Nasir and Sultan (2002) observed that nanophylls were the predominant life form in the Botanical Garden at Azakhel, District Nowshera, Pakistan [7]. In contrast, Hussain et al. (2014) investigated the flora of Sarsawa Hills, District Kotli, Azad Kashmir, and found different results. Sher & Khan (2007) reported similar findings from Chagharzai Valley of District Buner. Ajaib et al. (2008) noted that microphylls and leptophylls were the predominant leaf sizes from Baney Hills, District Kotli AJK, Pakistan, which supports our analysis. Khan et al. (2012) and Qadir and Tareen (2013) also reported similar results from Tehsil Takht-e-Nasrati, District Karak, and Quetta District, respectively. According to their findings, nanophylls and microphylls were the most common leaf size groups. Large leaf species occur in warm, moist climates, while smaller leaves are characteristic of dry and cold climates and degraded habitats.

Conclusion:

The study's results indicate that the dominant life forms and leaf size spectrum in Tehsil Karak, southern Pakistan, are therophytes and microphylls, respectively. The predominance of these life forms suggests significant human pressure and rapid deforestation in the area. The hot and dry weather conditions further shape the region's flora. Given these findings, it is crucial to implement targeted plantation and conservation strategies to protect the flora from both natural and anthropogenic challenges, particularly in the context of climate change. Identifying and propagating indicator species to establish green belts is recommended to enhance the region's ecological resilience and mitigate the impacts of changing climate conditions.

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Conflict of Interest.

The authors declare that they have no conflict of interest.

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