

## **NATIVE VEGETATION CORRELATION WITH ENVIRONMENTAL GRADIENTS BY MULTIVARIATE APPROACHES IN VARIOUS MICROHABITATS OF SEMIARID SUBTROPICAL REGION, DISTRICT MANDI BAHU UDDIN OF PUNJAB, PAKISTAN**

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### **ABSTRACT**

Documentation of vegetation is aimed at conservation of geographical ecosystems, and it is determined by its environmental dynamics. To fulfill this research gap in term of exploration of wild native flora and its association with environmental features in semiarid subtropical region, district Mandi Baha Uddin (MB Din) of Punjab, Pakistan is comprehensively explored. To record the vegetation and related environmental data, MB Din district was surveyed for three years during 2021 to 2023. Native plant species of target district were taken as sample for present study. The data was collected through random sampling method from 90 sampling stations having 270 quadrates among dynamic microhabitats (microclimates) Canoco ver. 4.5 and R ver. 4.4.2 software packages were practiced to measure the diversity indices and link the vegetation with environmental features. Diversity indices analysis by PAST software ver. 4.10 indicated that leading values of Simpson and Shannon diversity were observed in diversity rich habitats including grassland (0.0986 and 4.44) and forest land (0.0985 and 4.40) habitats, whereas same Simpson and Shannon diversity least diversity values were recorded in barrage land (0.9455 and 3.038) and Wetland land (0.9498 and 3.057) habitats. Recording of least diversity indices values indicated that these habitats are vulnerable for native species distribution. Detrended correspondence analysis (DCA) depicted the dissimilar vegetation distribution in various elevations. PCA (Principal component analysis) depicted that various microhabitats including Forest land, Roadside, Graveyards, Riverine land, Sandy land, Dry land and Waste places inhabit resembling species distribution whereas Grassland inhabit different flora. Canonical correspondence analysis (CCA) depicted that variation were recorded in ascending order with percentages of 18.8<30.9<42.5<52.5 for 1st, 2nd, 3rd and 4th axis of the whole variation. Edaphic environmental features including N, SOC, K, P, Sand and SOM depicted dominant association with native species distribution. This research highlighted the requirement for making conservation efforts and events to endorse vegetation in the target area.

**Key words:** Native vegetation, Multivariate approach, Environmental features, Mandi Baha Uddin, PCA, CCA.

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### **INTRODUCTION**

Vegetation is the diverse range of wild flora having idiosyncratic physiognomic features. Vegetation of specific geographical region reflects the environmental gradients, flora type and macro and microhabitat of defined area (Vojtkó *et al.*, 2020). The biological diversity plays an important role in data collection and designing measures for the long-term conservation of biodiversity to focus global changes caused by anthropogenic activities. Despite available data and sophisticated techniques in Ecology, still there are challenges to precisely study vegetation patterns and correlate underlie the processes defining the vegetation of a particular area. Vegetation species richness is one off

the important aspect of vegetation focused by Ecologists; that measures the biological variable forms already used in environmental research. Vegetation study of specific site and its environmental influence provide comprehensive ecological exploration, biological diversity and its conservation and management of associated ecosystem services in an environment friendly way to benefit humanity (Ahmed *et al.*, 2019; Majeed *et al.*, 2022).

Vegetation composition is mostly influenced at the fine-scale level by geographic features such as temperature, soil nutrients, potentially harmful metals, soil humidity, soil texture organic material, soil pH, erosion, and the quantity of total dissolved salts or soils electrical conductivity (Ali *et al.*, 2023). The expansion

and dynamic nature of habitats are pointedly influenced by edaphic features, which correspondingly alter the communities' structure and composition in space (Getzin *et al.*, 2008; Hulshof *et al.*, 2020).

Worldwide subtropical and semi-arid regions indicate exclusive and frequently delicate ecosystems that are crucial to understand the composite relationship among their different vegetation types and its environmental gradients (Phukon *et al.*, 2022; Waheed *et al.*, 2023). Various environmental factors correlated with phytodiversity in tropical and boreal zones are well known (Ali *et al.*, 2023). Soil conditions have been shown to affect plant species' distribution patterns in several researches conducted around the Globe (Anwar *et al.*, 2023; Majeed *et al.*, 2022). Inadequate water supply and dynamic environmental features of these regions require an inclusive investigation of their vegetation and ecological traits to get improve understanding of their environmental flexibility and compliance (Arshad *et al.*, 2022).

Nearly, 7000 vascular flora have been explored up to date throughout Pakistan, making it a unique breath-taking natural beauty land. North and West regions are inhabited by various endemic and rare flora (Khan *et al.*, 2019). Although, the ecology of Pakistan's subtropical and arid regions has been the subject of very rare assessment due to environmental variability caused by factors such as water scarcity, poor soil with inadequate nutrients, expanding population of humans and variable terrain, there is a striking variation in the responses and diversification patterns of plant species in these ecosystems (Ilyas *et al.*, 2018). Likewise, how the quantity of herbivore dungs in a plot may be used to assess the impact of grazing pressure; the number of stumps in a plot can also be used to assess the impact of deforestation pressure. This type of research also suggests that the distance from the closest farmland (as a proxy to estimate the human intervention for the closest natural vegetation and the distance from the next primary water source (alike a river in desert regions) might be significant determining factors (Majeed *et al.*, 2022). Ecologists documented studies in tropical and temperate regions of Pakistan to determine the biodiversity pattern and the environmental factors affected them. Soil quality, geography, climate, and human activities all have to be the focusing point of research of vegetation in various regions of Pakistan (Majeed *et al.*, 2022; Sadia *et al.*, 2017; Zeb *et al.*, 2020).

MB Din constitutes diverse environmental and habitat variations due to semi-arid subtropical location. Though floristic diversity is well known with reference to environmental factors in various areas of Punjab (Majeed *et al.*, 2021; 2022); KPK (Shah, 2022) and Western Himalayan (Haq *et al.*, 2022), still documentation of Phyto diversity and its environmental gradients linkage within in district MB Din, Punjab, Pakistan is incomplete.

A recent study has reported Invasive species of the district comprehensively (Jamil *et al.*, 2022). Current study was planned to fulfill the gap of (i) baseline vegetation exploration of semiarid subtropical region district MB Din by multivariate approaches and (ii) distribution pattern of native species in association with various environmental features in the research area. The findings of this study will provide a foundation for future ecologists to conserve biological diversity in dynamics environmental conditions.

## MATERIALS AND METHODS

**Research site:** MB Din district is situated between latitude 32° 34' N and longitude 73° 28' E bordered by Chenab river in the southeast side unravelling it into Hafizabad and Gujranwala districts. Its Eastern side is bounded by Gujrat district while Northern side is bounded by Jhelum river (Majeed *et al.*, 2021). Average minimum and maximum temperature ranges between 3 °C and 48 °C in winter and summers, with mean precipitation rate of 388 millimeters. The alluvial region of the district is dominantly plain and has been divided into various habitat types on the basis of dynamic physiognomy, vegetation structure, edaphology and physiography. It also has forestry zones in terms of natural forests including Bella forest, Rasul Barrage forest, Qadir Abad forest and rangeland forests counting Dapher forest. Dynamic habitats comprise of agriculture, forests, rivers, upland area, roadside areas and graveyards.

**Vegetation data collection:** To explore the vegetation, various field surveys were conducted during 2021-2023 (3 years). Ecological data was recorded from entire district based on geographical and vegetation heterogeneity by randomly placing 270 quadrates of 90 sampled sites. Sample sites were positioned among various microhabitats (having dynamic microclimatic conditions with respect to species richness, physiognomy, physiography and soil types) including grassland, wetland, barrage land, sandy land, forest land, dry land, roadsides, graveyard and waste land areas. For each sampling site, quadrats size was variable for all the three layers in term of 10 × 10 m<sup>2</sup> for trees following 5 × 5 m<sup>2</sup> for shrubs and 1 × 1 m<sup>2</sup> for herbs and grasses. The main consideration of the research was to record the vernacular and botanical names of native plant species and their distribution geographically.

After proper collection, each of the floral specimens was tagged, photographed, entirely desiccated by standard protocols and framed on international standard size herbarium sheets. Usage of applications / websites was performed in terms of Flora of Pakistan (<https://www.tropicos.org>) updated on 27<sup>th</sup> August 2023 and Plant of World online (<https://powo.science.kew.org>)

for identification of wild flora and cross matching (Jamil *et al.*, 2022). Phytosociological parameters including density, frequency, cover and importance values of all the native species were recorded and laid on MS excel sheet for various analysis. After following standard protocols, mounted plant specimens were submitted to the herbarium established at Department of Botany,

University of Gujrat, Punjab, Pakistan for record. Various geographic aspects in term of latitude, elevation and longitude of each site were determined and positioned on research map by employing Garmin e-Trex, Global Positioning System (GPS) (Jamil *et al.*, 2022) as pointed in Figure 1.

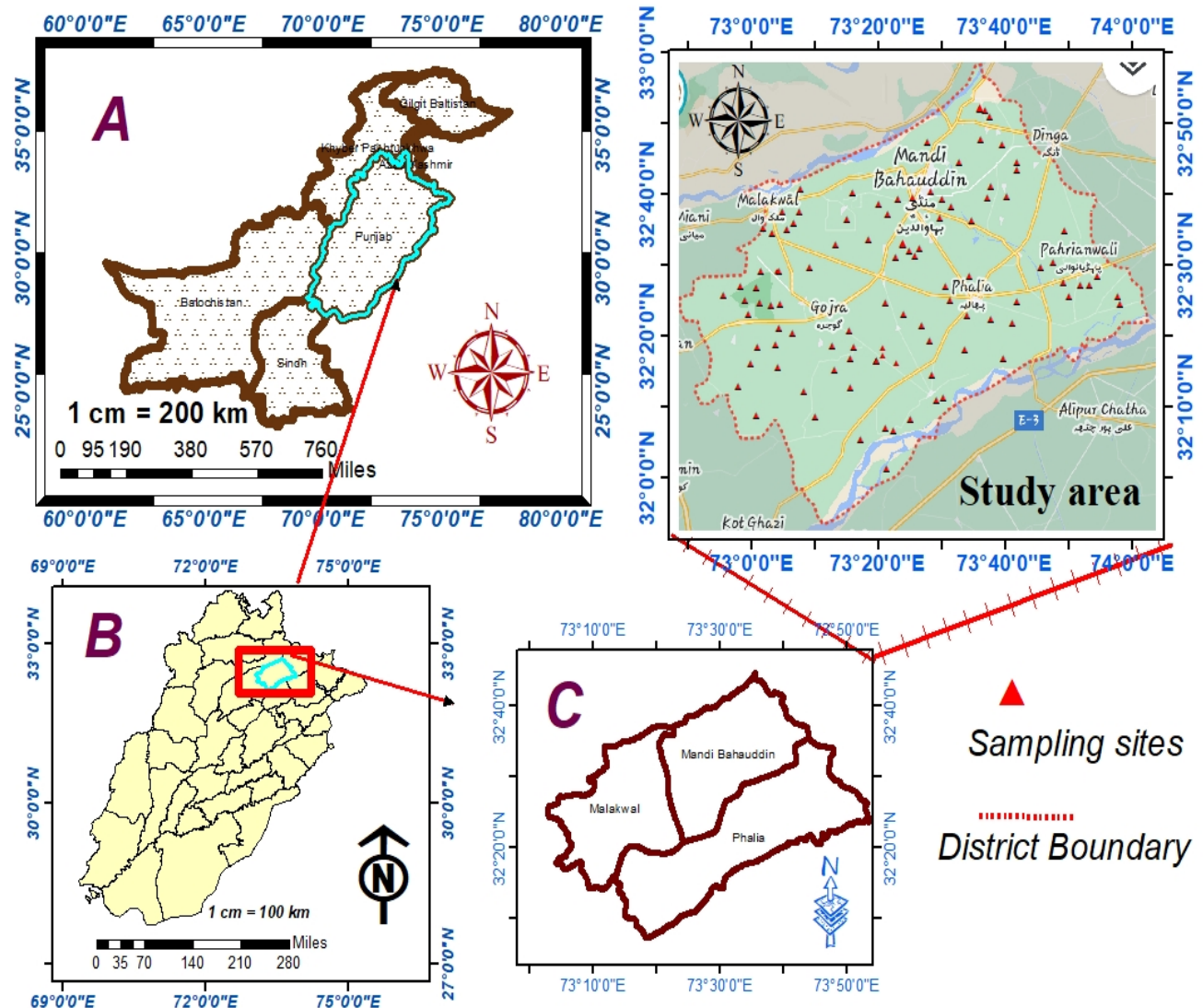


Figure 1: Map representing the different sampling points for species and soil samples in district MB Din

**Phytogeographical analysis:**The native flora of Punjab, Pakistan was acknowledged by using the Flora of Pakistan (tropicos); Plants of World Online (POWO), online web pages GRIN: Germplasm Resource Information Network (<https://www.ars-grin.gov/>), manuals and recently published literature (Naz *et al.*, 2019; Haq *et al.*, 2019; 2022; Jamil *et al.*, 2022).

**Soil sampling and edaphic features analysis:** Composite samples of soil weighing 500 g were

randomly gathered in triplicates from each of 90 positioned sampled sites of entire district. All of the samples were pooled together for further examination. Three days of sun drying was applied to the soil. Sand (particle size: 0.05 – 2.0 mm), silt (particle size: 0.002 – 0.05 mm) and clay (particle size: 0.075 mm) were all measured. There were clear labels on the polythene bags and the samples have been mixed, weighed and dried. Each sample was tagged with the identity of the collector,

the day it was collected and the site where the research was conducted to get the findings. Soil pH level was evaluated by means of an electronic pH meter. EC meter was used to make the assessment of electric conductivity (Jamil *et al.*, 2022). Several other physicochemical characteristics of the soil including the soil's texture, saturation, organic matter and percentages of potassium, nitrogen, calcium carbonate and phosphorus were measured for each soil sample in soil and water testing laboratory, Sialkot (Majeed *et al.*, 2022).

**Diversity indices Analysis:** The assembled phytosociological data of native plants and their environmental feature were organized and arranged in MS (Microsoft Excel) sheet 2015 for successive analysis by the use of PAST software ver. 4.10. Vegetation indices including Simpson's Index, Margalf and Shannon Index (H) were employed to find out the species richness, evenness, abundance and dominance values by using latest version of PAST software (Jamil *et al.*, 2022).

**Ordination Analysis and Vegetation-Environment associations:** The DCA (detrended correspondence analysis) diagram determines the native species composition and distribution in space, whereas CCA (canonical correspondence analysis) diagram reveals that how the environmental variables impact on native species diversity, composition and distribution. Vegetation distribution in various locations or elevations of research district was determined by indirect gradient analysis technique DCA (detrended correspondence analysis). R language ver. 4.4.2 was used to find out the PCA (Principal Component Analysis) plot representing the native plant species distribution among various microhabitats of entire district. Canoco software ver. 4.5 was used for examining the association of environmental features with native species distribution of research(target) district by direct gradient analysis of multivariate method CCA (canonical correspondence analysis) (Majeed *et al.*, 2022). The significant basic function of DCA and CCA is to find out species distribution and correlation among native vegetation distribution along with their environmental features.

## RESULTS AND DISCUSSION

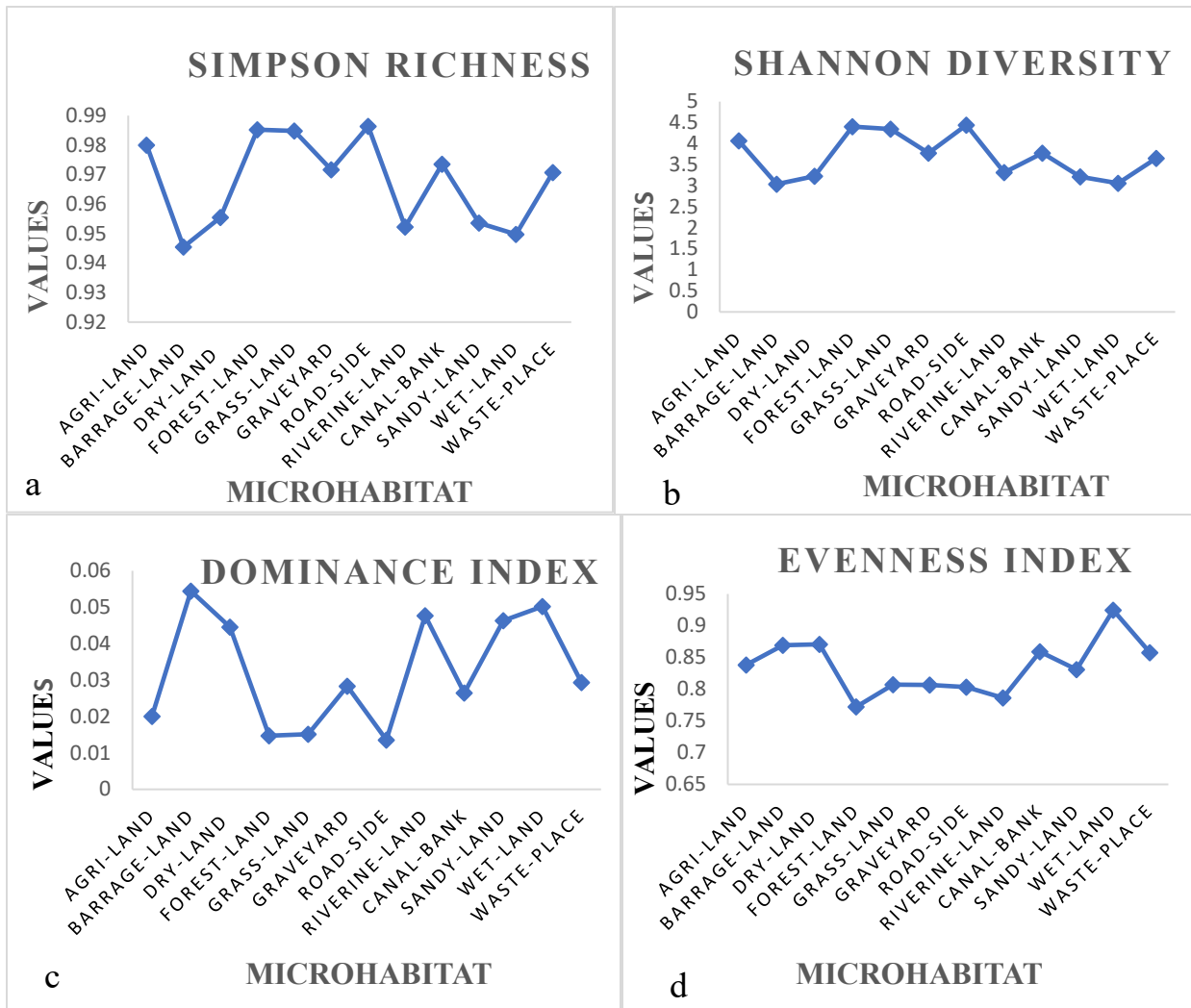
MB Din is socioeconomically vital region characterized by semi-arid subtropical conditions. Its dynamic soil and environmental features are intricately linked with its diverse vegetation making it a unique and ecologically significant area (Jamil *et al.*, 2022). Over 29 % of Earth's geographical area is comprised of arid and semiarid regions and these dry lands are responsible for providing services for more than a billion people. Primary producers like plants and trees play a crucial role in every ecosystem by providing food and shelter for animals. The most ecologically important functions of native vegetation in dry tropical habitats is its ability to prevent soil erosion (Murgueitio *et al.*, 2011). Both species loss and habitat deterioration are linked to desertification. Vegetation analyses and other ecological studies are crucial for understanding the temporal and spatial patterns in species composition and the environmental conditions that drive them in the dry tropics. Researchers also looked at the ecological functions of vegetation and this type of research plays a significant role in the creation and implementation of conservation and management plans for dry tropical hotspots.

**Diversity Indices of Native species of district MB Din:** The diversity indices of native species demonstrated particular differences in distribution of species in various habitats. Simpson richness and Shannon evenness diversity values were recorded leading in the roadside (0.986 and 4.444), forest land (0.985 and 4.40), grassland (0.986 and 4.35), and habitats indicating that these habitats support native vegetation distribution compared to others. Diversity indices diagram of dominance showed the values range from 0.014 to 0.054 among which leading dominance values were recorded in barrage land (0.054) and wetland (0.050) habitats that also support the native species. Least Simpson richness and Shannon evenness values were recorded in Barrage land (0.9455) and (3.038) and Wetland land (0.9498) and (3.057) habitats highlighting that these habitats are vulnerable to native species distribution (Figure 2. a, b, c, d) (Table 1).

**Table 1: Representation of diversity indices of Native species distribution in MB Din**

S. No.	Habitat	Dominance D	Simpson 1-	Shannon H	Evenness
1	Agri-Land	0.02003	0.982	4.072	0.8382
2	Barrage-land	0.05447	0.9455	3.038	0.8693
3	Dry-Land	0.04453	0.9555	3.229	0.8705
4	Forest-land	0.01476	0.9852	4.405	0.7721
5	Grass-Land	0.01518	0.9848	4.35	0.807
6	Graveyard	0.02832	0.9717	3.774	0.8067
8	Road-Side	0.01357	0.9864	4.444	0.8031
9	Riverine-land	0.04768	0.9523	3.315	0.7861

10	Canal-bank	0.02647	0.9735	3.78	0.8592
11	Sandy-land	0.04635	0.9536	3.216	0.8309
12	Wet-Land	0.05025	0.9498	3.057	0.9246
13	Waste-Place	0.02931	0.9707	3.653	0.8574



**Figure 2: Different diversity indices of native plants species in various habitat types in district MB Din. The bar-graph diagram shows the sampling sites vegetation with letters of remarkable difference among dissimilar habitat types.**

Outcomes of our research revealed that average Simpson and Shannon's diversity values reported in this region were comparable to the Western Himalayan Woodlands of Pakistan (Waheed *et al.*, 2023), highlighting the relative high plant variety, and no prior study in this semiarid tropical region had been conveyed these values. Ordination analysis (DCA) depicted the distribution of different native species with respect to elevation gradients.

**DCA (Detrended Correspondence Analysis) for elevational distribution of Vegetation:**The environmental gradients are well explained by DCA

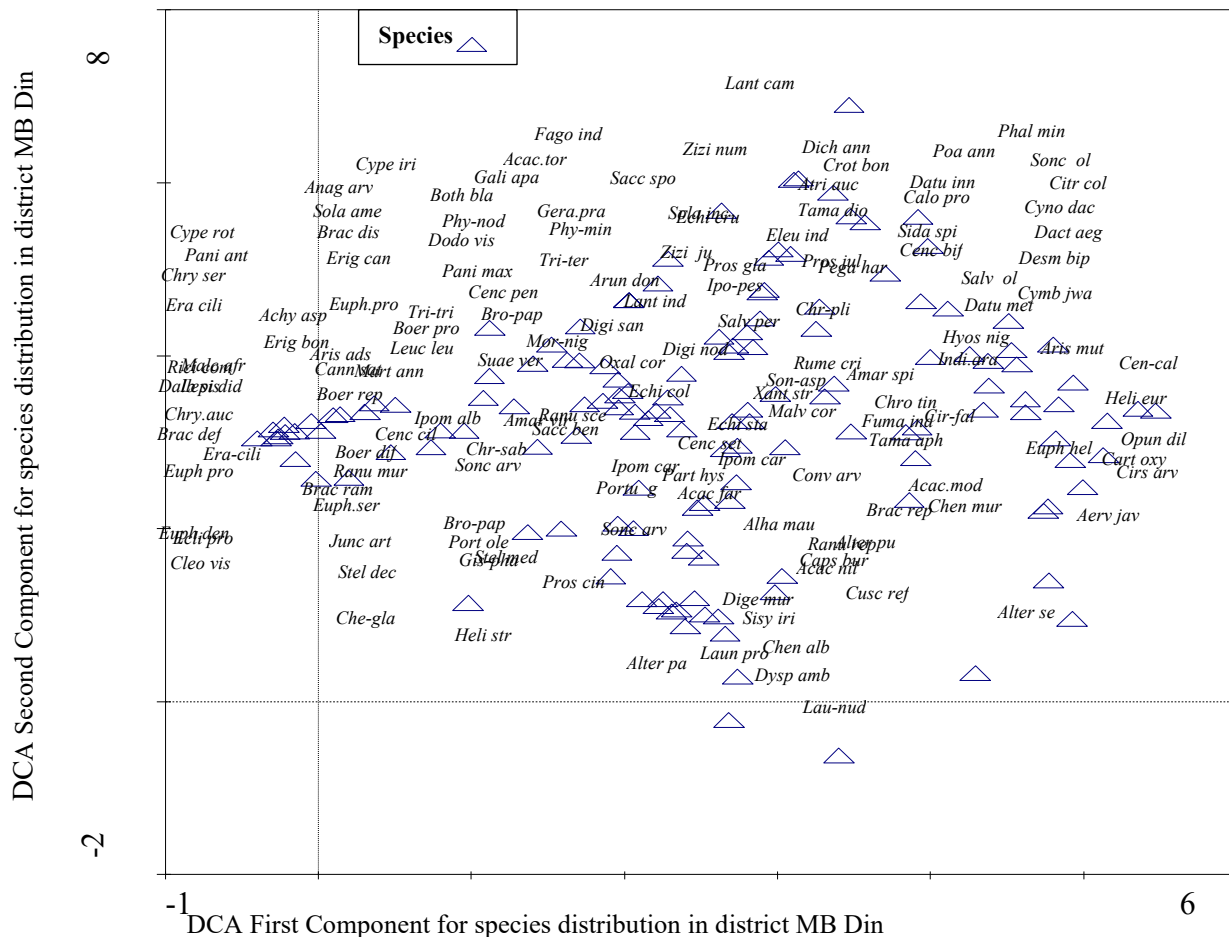
(Detrended Correspondence Analysis). The first two axis described 13.6% and 21.5% of the cumulative variance of species data variance (Table 2) that was an ordination plot and plotted by employing Canoco software. For improved graphical interpretation, ordination results were employed to categorize the sampling species. The first DCA axis revealed the elevation gradient between the native species and habitat types. Species and sites of lower elevation (666-741 m) were clustered to the left side while sites of the higher altitude (792-866 m) were grouped to the right side of the DCA diagram. This also demonstrates the latitudinal and elevation gradient complex of the research area i.e., the sites at the initial of

district Mandi Baha Uddin are grouped on the left side are of lower latitudes and the further distant sites are of higher latitudes clustered on the right part of DCA diagram with reference to first axis. Plant species and sites of less xeric habitats grassland and roadside habitats are or grouped to the left side of the species ordination DCA diagram whereas native species and sites of xeric habitats including Dry land, Forestland, Sandy land and Barrage land (at middle or high elevations) are clustered on the right side of DCA diagram although the species

and sites of lower to middle elevations including Wet land and Canal bank habitats are clustered in the central part of DCA diagram. The species are placed at distance in ordination diagram *Launaea nudicaulis*, *Lantana camara* and *Launaea procumbens* are rarely affected by environmental gradient. The outcomes of DCA ordination diagram reveal the complex elevation, latitudinal and environmental gradient among the vegetation (Table 2) (Figure 3).

**Table 2: Description of the first four axes of the DCA for the vegetation data (using the matrix species with their Importance Values (IVI))**

Axis	1	2	3	4	Total inertia
Eigenvalues	0.779	0.458	0.269	0.205	5.748
Lengths of gradient	4.595	4.912	3.647	3.41	
Cumulative percentage variance of species data	13.6	21.5	26.2	29.8	
Sum of all eigenvalues =	5.748				



**Figure 3: DCA (Detrended Correspondence Analysis) plot representing the native plant species distribution in district MB Din**

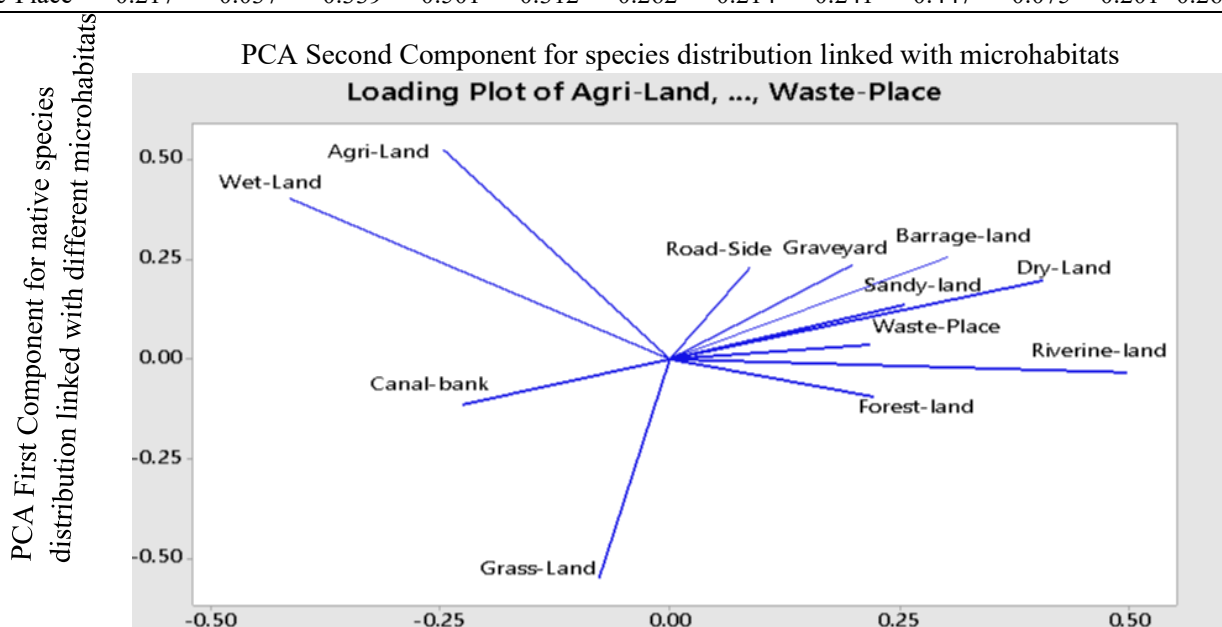
Literature has suggested supportive study using multivariate regression approaches to examine the species environment correlation (Majeed *et al.*, 2022) of 291 species and 30 predictors (environmental variables) throughout the 303 sampling stations in nearby region, district Jhelum of Punjab, Pakistan. Variations in regenerative and competition processes are a direct outcome of spatial variation in microhabitats. Vegetation types and major indicators of each vegetation association were found in various habitats (microhabitats) and their respective species compositions were recorded for the first time in the respective district. All of these are crucial to any research of vegetation if results are to be compared realistically to those of other literature (Ali *et al.*, 2023).

**PCA (Principal Component Analysis) loading plot for Vegetation distribution among various microhabitats**

Principal component analysis uncovers the species richness and distribution patterns to investigate substantial association among native species with their sampling sites of the dynamic ecosystems. Forest land, Roadside, Graveyards, Riverine land, Sandy land, Dry land and Waste places inhabit resembling species distribution placed on 1st quadrat of PCA (Principal Component Analysis) loading plot with minimum variation whereas these habitats show negative association with other habitats including Wet land, Agricultural land and Canal bank of 2nd quadrat of PCA Biplot. Grass land habitat inhabits much dissimilar type of vegetation comparatively to all other habitats represented in (Figure 4) (Table 3).

**Table 3: PCA (Principal Component Analysis) shows microhabitats-based diversity values of native vegetation of MB Din**

Variable	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12
Agri-Land	-0.247	0.526	0.091	-0.117	0.023	-0.153	0.394	-0.226	0.316	0.498	-0.241	0.063
Barrage-land	0.302	0.255	-0.222	-0.071	0.213	-0.563	-0.232	-0.259	-0.269	-0.247	-0.374	0.184
Dry-Land	0.406	0.198	-0.162	0.417	0.097	0.173	0.149	0.397	-0.079	0.161	-0.367	-0.457
Forest-land	0.222	-0.094	0.310	-0.357	-0.101	-0.529	0.116	0.583	0.251	-0.033	0.069	-0.068
Grass-Land	-0.078	-0.552	0.184	0.065	0.380	-0.110	0.209	-0.329	0.303	-0.160	-0.349	-0.321
Graveyard	0.199	0.235	0.445	0.279	0.387	0.086	0.427	-0.006	-0.125	-0.319	0.284	0.304
Road-Side	0.087	0.231	0.083	-0.415	0.427	0.465	-0.393	0.153	0.352	-0.134	-0.186	0.080
Riverine-land	0.497	-0.035	0.171	0.016	0.165	-0.085	-0.294	-0.349	0.079	0.485	0.439	-0.211
Canal-bank	-0.225	-0.114	0.589	0.253	0.023	-0.045	-0.389	0.158	-0.290	0.317	-0.344	0.209
Sandy-land	0.254	0.136	0.230	0.320	-0.573	0.052	-0.173	-0.216	0.483	-0.296	-0.157	0.088
Wet-Land	-0.414	0.403	0.192	0.086	0.056	-0.183	-0.249	-0.025	-0.056	-0.298	0.223	-0.617
Waste-Place	0.217	0.037	0.339	-0.501	-0.312	0.262	0.214	-0.241	-0.447	-0.075	-0.201	-0.263



**Figure 4: PCA (Principal Component Analysis) plot representing the native plant species distribution in various microhabitats of MB Din**

In support to our findings, the use of various geographical locations in term of microhabitats for recording the wild vegetation was also conducted by Haq *et al.*, (2019; 2023) in Keran valley and Shawilks region of Western Himalayan and investigated that forest land and roadside habitats scape inhabit maximum vegetation.

**Impact of Environmental gradients on the distribution of Vegetation by CCA:** The results of direct gradient analysis (CCA) make it obvious that specific environmental variables including pH, SOC (soil organic constituents), SOM (soil organic matter), N, K, P, silt, sand, clay and EC (electric conductivity) showed a significant influence on native species distribution (Figure 5). CCA tri-plot also showed the distribution of native species among various microhabitats including dry land, wet land, forest land, grassland, graveyard, barrage land, agricultural land, riverine land, sandy land and waste places in term of small circles (Figure 6). The distance between circles reveals about the similarity of microhabitats to one another. First quadrat of CCA indicated that N, silt and EC were positively influencing on species distribution whereas second quadrat represented that soil pH and clay were foremost edaphic factor negatively associated with native species distribution. Third quadrat of CCA showed that soil organic matter and potassium had greater impacts on species distribution while sand, P and soil organic constituents control the native species distribution in fourth quadrat of the CCA

diagram. Additionally, the species including *Atriplex aucheri*, *Carthamus oxyacantha*, *Chrozophora sabulosa*, *Fagonia indica*, *Rumex dentatus*, *Justicia adhatoda*, *Tamarix dioica*, *Vicia bakeri* and *Saccharum spontaneum* respectively showed positive association with N, silt and EC were found mostly in dry-land, wet-land, forest land and canal bank habitats as showed in 1st quadrat of CCA whereas 2nd quadrat of CCA represents Road side and Waste place were leading habitats for the distribution of sensitive species including *Acacia farnesiana*, *Angellis arvensis*, *Cenchrus divinus*, *Chrozophora tinctoria*, *Dicliptera bupleuroides*, *Melilotus indicus*, *Mentha longifolia*, *Sisbrium irio* and *Sonchus asper* respectively. Native species that were controlled by SOM and K in Agricultural land and Grassland were comprised of *Arundo donax*, *Chenopodium album*, *Chenopodium murale*, *Cenchrus setiger*, *Galium aparine*, *Malva neglecta* *Mentha royleana*, *Poa annua* and the species of 4th CCA quadrat in Graveyards and Riverine land influenced by SOC were comprised of *Acacia torta*, *Fumaria indica*, *Prosopis juliflor*, *Rhazya stricta*, *Sida spinosa*, *Salvadora oleoides* and *Tamarix aphylla* respectively. Variation was recorded in ascending order 18.8<30.9<42.5<52.5 for 1st, 2nd, 3rd and 4th axis of the whole variation representing that the SOC, K, P, Sand and SOM have maximum association and particular influence on native species distribution pattern (Figures 5 and 6) (Table 4 and 5).

**Table 4: Description of the first four axis of the CCA for the vegetation data (using the matrix species with their Importance Values (IVI))**

Axis	1	2	3	4	Total inertia
Eigenvalues	0.198	0.129	0.123	0.100	1.073
Species-environment correlations	0.991	1.000	0.998	0.993	
Cumulative percentage variance of species data	18.4	30.4	41.9	51.2	
Var. of species-environment relation	22.4	37.0	50.9	62.2	
Sum of all eigenvalues	= 1.073				
Sum of all canonical eigenvalues	= 0.883				

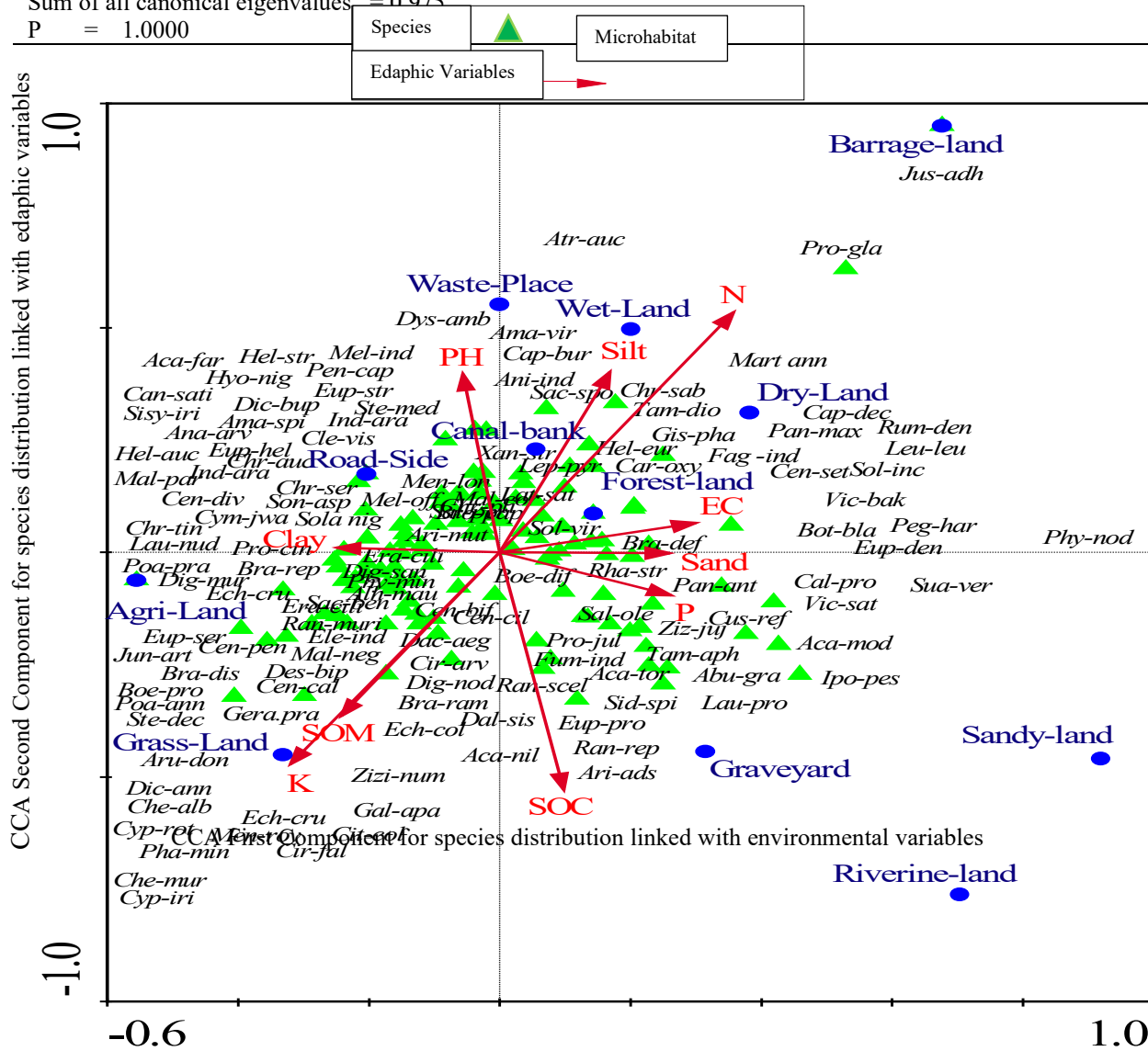
Environmental gradients including soil features in term of N, K, P, Sand, SOC and SOM showed leading impact whereas P, EC and soil texture showed least impact on vegetation distribution of district MB Din (Jamil *et al.*, 2022). Hence, the research in semiarid region, district Mandi Baha Uddin, Punjab, Pakistan was set out to identify the plant types that vary from one another in terms of species composition, structural complexity and the environmental factors that ultimately shape them. So, the second aim of this research was to investigate for the first time, the environmental elements comprising of ecological and geographical factors that could be responsible for the changes in vegetation

composition. (Khan *et al.*, 2019) also documented the influence of edaphic and physiographic aspects on vegetation of Sathan Gali reserved forests of KPK, Pakistan. According to botanist (Arshad *et al.*, 2024), who reviewed the impact of environmental factors on medicinal plants after surveying 11 forest sites in subtropical region during 2021 to 2022 by practicing CCA and regression analysis. His research investigated those anthropogenic features and edaphic variable including N, soil O.M., K and P that implies positive impact whereas soil pH and (EC) electrical conductance implies negative influence on medicinal plants distribution ( $p \leq 0.002$ ). In most recent research similar to



**Table 5: Description of the first four axis of the CCA for the vegetation data (using the matrix species with their Importance Values (IVI))**

Axis	1	2	3	4	Total inertia
Eigenvalues	0.202	0.130	0.124	0.108	1.075
Species-environment correlation	0.998	1.000	0.998	0.995	
Cumulative %age variance of species data	18.8	30.9	42.5	52.5	
Cumulative %age of species-environment relation	20.7	34.1	46.8	57.8	
Sum of all eigenvalues =	1.075				
Sum of all canonical eigenvalues =	0.975				
P =	1.0000				



**Figure 6: CCA tri-plot representing the native species distribution along the environmental variables**

**Conclusion:** Nestled between the life-giving Chenab and Jhelum rivers with fertile alluvial plains and diverse environment, MB Din is blessed with a wide range of vegetation. Diversity indices analysis indicated that Grassland, Forest land and Roadside habitats have supported the native species distribution whereas Barrage land and Wetland have rare diversity of species

that reflect the dynamic edaphic and geographic adaptation of research flora for these habitats. Forest land, Roadside, Graveyards, Riverine land, Sandy land, Dry land and Waste places inhabit resembling species distribution whereas Grassland inhabit different flora. It was concluded that soil of research district was rich in micronutrients and from which N, K, pH and SOM show

maximum influence whereas EC, sand and P show least influence on vegetation distribution among various microhabitats in district MB Din. The influence of environmental challenges might execute the enduring damage to native vegetation in semiarid subtropical region. Policy makers, rangeland managers and ecologists may use this research for conservational and socioeconomic point of view. Conservation of vital eatable medicinal species should be encouraged.

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**Conflict of interests.** The authors declare that they have no competing interests and carefully addressed ethical issues during submission of article.

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