

ORDINAL CLASSIFICATION OF VEGETATION ALONG MANGLA DAM, MIRPUR, AJK

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Abstract

Vegetation plays an important role in ecosystem maintenance. But the construction of dams transform the riparian vegetation into impoundment region. The present study was conducted to identify and quantify herbaceous flora around the vicinity of Mangla dam. Study area was divided into two zones on the basis of distance from the dam boundary. Pattern of vegetation distribution and their association in area was grouped in to different communities by using ordination techniques. Two ordination techniques TWINSpan and DECORANA were used. A total of 37 species belonging to 17 families were identified from fifty quadrats. Random sampling was done by using 1 × 1 m sized quadrat. Percentage of vegetation was assessed by using Domin cover scale. TWINSpan classified two groups and four communities in Zone-I, while in Zone-II two groups and six communities were formed. Dominance curve showed that *Cynodon dactylon*, *Desmostachya bipinnata* and *Rhynchosia minima* were dominant species in Zone-I and *Croton bonplandianus*, *C. dactylon*, *D. bipinnata* and *Brachiaria decumbens* were frequent species in Zone-II. DCA as indirect multivariate technique based on reciprocal averaging determined the environmental gradients that affect the species richness and also verified the groups of species and indicated four communities in both Zones. Monte Carlo test of significance was used to analyze stress in relation to number of axis/dimensionality under Non-metric Multidimensional Scaling (NMS) through p-value. This study provided the significant results of least abundant and most abundant herbaceous species around the dam which will be helpful for biodiversity conservation and in decision making for further land planning.

Key words: Herbaceous flora; TWINSpan; DCA; NMS ordination; Dam.

Introduction

Dam's construction is important for any country's economy. But globally dams are known as leading driver that apparently changes the ecosystem of watershed (He *et al.*, 2004). Dams having significant negative consequences for the surrounding natural ecosystems resources (New & Xie, 2008). In terrestrial ecosystem, both the riparian vegetation and wildlife habitat can be affected by dam projects and ultimately affect the sustainability of ecosystem (Silva *et al.*, 2010; Grumbine & Xu, 2011). Riparian vegetation plays very important role in ecosystem sustainability. Vegetation along the dam provides protection to water quality by reducing soil erosion and sedimentation. Therefore, it is imperative to classify the existing herbaceous flora around the dam. Vegetation can be classified by using multivariate or ordination techniques in which species are arranged along the gradients. Ordination techniques are widely used method in ecology for vegetation data analysis, involving classifying and arranging species hierarchically. That's why mostly ecologist uses Two Way Indicator Species Analysis (TWINSpan) and Detrended Correspondence Analysis (DCA) ordination techniques (Hill, 1979). TWINSpan divided the cover percent of flora in to cut levels which indicate the presence and abundance of each species by producing Two Way Cluster Dendrogram and also present the species distribution in graph formation. Whereas DCA as indirect gradient analysis use to ordinate the species data and verifying the formation of communities under TWINSpan results (Hill & Gauch, 1980; Ahmad *et al.*, 2014a). In one study TWINSpan was used in classification of vegetation by researchers in order to assess the impact of dam operation in particular area. Samples were collected from 126 quadrats. Total 21

species were identified. It has also been reported by different researches that during the construction and operation of dam building, vegetation in area was declined and changed due to the shifting of their habitats (Jinpeng *et al.*, 2012).

Main objective of the present study was to quantify the existing herbaceous flora around Mangla dam by using ordination techniques. The study was carried out around Mangla Dam, situated in Mirpur District, Azad Kashmir. It is first dam of Pakistan, built on river Jhelum in 1967 and covered 26500 ha total area. Study area was divided in to two Zones: Zone-I; Zone-II. Zone-I was demarcated from dam boundary to running road around the dam and Zone-II was the area beyond the road (Fig. 1).

Materials and Methods

Extensive field survey was conducted for plant sample collection when growing season started and plants were in flowering stage. Total fifty quadrats of 1×1 square meters were laid down in two Zones. Thirty and twenty quadrats were tossed randomly in Zone-I and Zone-II respectively. Flora from each selected quadrat was collected by using Braun-Blanquet method. Whereas domin cover scale was used for estimating cover value of each species from each quadrat (Kent & Coker, 1995). For vegetation classification Two Way Indicator Species Analysis was applied by using PCORD program as the result of which Two-Way ordered table was formulated, which depicted abundance of each specie in each quadrat. Whereas Dendrogram was created under TWINSpan for assessing grouping and communities formed by existing vegetation in the study area. Another indirect ordination technique for verification of TWINSpan results, Detrended Correspondence Analysis was applied on

species data set (Hill, 1979; Ahmad *et al.*, 2014b, 2014c). Besides dominance curve was also created between Log values of sum abundance and rank of abundance which described the ranks of species on their abundance/frequency of existence in study area. Whereas another multivariate technique Nonmetric Multidimensional Scaling was used to show the stress on the basis of distance by fitting data in to dimensions.

TWINSpan: TWINSpan classified species composition in both Zones. In Zone-I TWINSpan percentage cover scale was divided in to six using five cut levels and three cut level in Zone-II. Species hierarchy was shown by graphical presentation in form of Two-Way Cluster Dendrogram, which divided into two main groups A and B in each Zone. In Zone-I Group A contained one specie i.e. *C. dactylon*. Whereas Group B was further divided in to four communities showing in different colours (Fig. 2). This indicated frequency of species in particular quadrats and association with other species to form community against similar environmental condition in area. Community I comprised six species i.e. *Achyranthes aspera*, *B. decumbens*, *Eleusine indica*, *Cannabis sativa*, *Conyza Canadensis* and *Tephrosia purpurea*. The name given to this community was *Cannabis-Eleusine (Can-Ele)* on the basis of dominant species under Group B. Community II was largest community under Group B comprised of fourteen species, *Alternanthera pungens*, *Convolvulus arvensis*, *Cenchrus ciliaris*, *Chenopodium album*, *Dactyloctenium aegyptium*, *Euphorbia hirta*, *Heliotropium europaeum*, *Heteropogon contortus*, *Lantana camara*, *Malvastrum coromendelianum*, *Coronopus didymus*, *Oxalis corniculata*, *D. bipinnata*, *C. bonplandianus* and named as *Croton-Desmostachya (Cro-Des)*. Community III under division of Group B comprised of three species which dominated by *Parthenium hysterophorus* while *Taraxacum officinalis* and *Dichanthium annulatum* were having the same diversity in this area. So this community was allotted two names i.e. *Parthenium-Taraxacum (Par-Tar)* or *Parthenium-Dichanthium (Par-Dic)*. The fourth community consisted of four species *Amaranthus spinosus*, *Medicago polymorpha*, *Conyza bonariensis* and *R. minima*. A dominant specie *R. minimum* is followed by *C. bonariensis* that's why this community named *Rhynchosia-Conyza (Rhy-Con)*. Whereas the most diverse species in Zone-I is *C. dactylon* which made the Group A but did not found within any one of the community which has been shown in Fig. 2. *Aristida adscensionis* is specie that did not formed community with any one species but as whole it made group B with other species in group.

Results

Total 37 herbaceous species belonging to 17 families were identified around Mangla dam. Twenty nine and twenty three species were found in Zone-I and Zone-II respectively.

In Zone-II, TWINSpan divided the vegetation into two major group, Group A and Group B. Group B was

further led to division in to five communities among which the largest community was Community II (Fig. 3). Community I comprised of four species that were *Aerva javanica*, *L. camara*, *Pupalia lappacea* and *R. minima*. Whereas this community was dominated by *Lantana* and *Pupalia* and named as *Lantana-Pupalia (Lan-Pup)* based upon their greater diversity. Community II comprised of six plant species and this is largest community in Zone-II having named as *Dactyloctenium-Launaea (Dac-Lau)* because among *A. spinosus*, *Artemisia scoparia*, *C. sativa*, *Dactyloctenium aegyptium*, *H. contortus* and *Launaea procumbens*, the dominant species were *Dactyloctenium* and *Launaea*. Next Community III was dominant by *B. decumbens* and *E. hirta* and named on basis of their dominance as *Brachiaria-Euphorbia (Bra-Eup)* community whereas it comprised of three species. Along these two dominant species other one is *Argemone mexicana*. *A. adscensionis*, *Cucumis melo var agrestis*, *Euphorbia prostrata*, *T. officinalis* and *P. hysterophorus* comprised by Community IV. Among all, *Parthenium* and *Cucumis melo* were dominant in this community as shown in Fig. 3. This community named on basis of dominant species was *Parthenium-Cucumis (Par-Cuc)*. *Desmostachya-Malvastrum (Des-Mal)* community named after having dominant specie. This community lies under Community V of Group B and had three species *D. bipinnata*, *M. coromendelianum* and *Solanum surrattense*. Community VI under Group A consisted only two species but these two were found in abundance in Zone II i.e. *C. bonplandianus* and *C. dactylon*, and named as *Cynodon-Croton (Cyn-Cro)* community.

DCA: DCA as an indirect ordination technique used to verify the results of TWINSpan. In Zone I four communities were formed.

Group 01: Group 1 comprised of *A. aspera*, *B. decumbens*, *E. indica*, *C. sativa* and *T. purpurea*.

Group 02: This group included *H. contortus*, *L. camara*, *C. didymus*, *D. bipinnata*, seems similar to Two Way Indicator Species (Fig. 2).

Group 03: *P. hysterophorus* and *T. officinalis* covers in this group.

Group 04: Group 4 contained two species i.e. *C. dactylon* and *C. bonariensis*. Whereas *C. album* and *C. Canadensis* did not presented any interaction with the other species and shown as outlier in DCA (Fig. 4).

In Zone-II four groups were formed (Fig. 5). These groups encompassed following species.

Group 01: *A. javanica*, *L. camara* and *P. lappacea*.

Group 02: *A. spinosus* and *A. scoparia*.

Group 03: *B. decumbens*, *E. hirta* and *A. Mexicana*

Group 04: *A. adscensionis*, *Cucumis melo var agrestis*, *E. prostrate*, and *P. hysterophorus*.

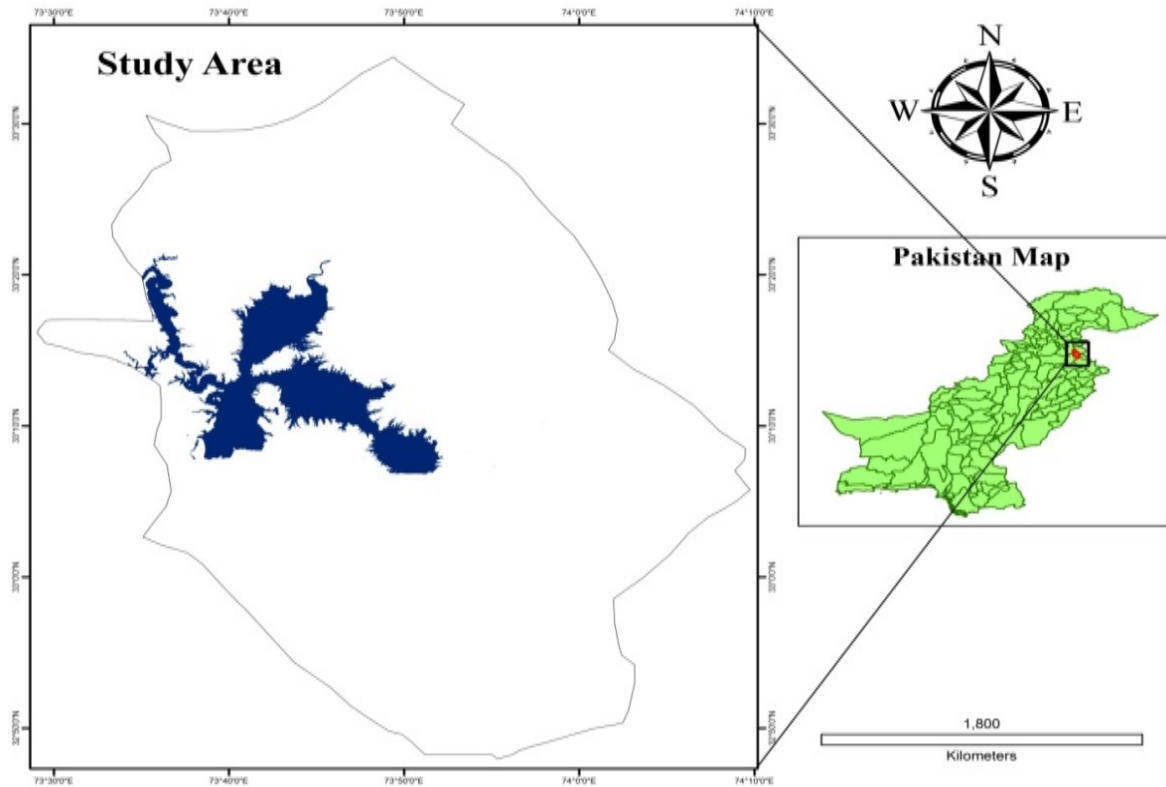


Fig. 1. Location map of study area.

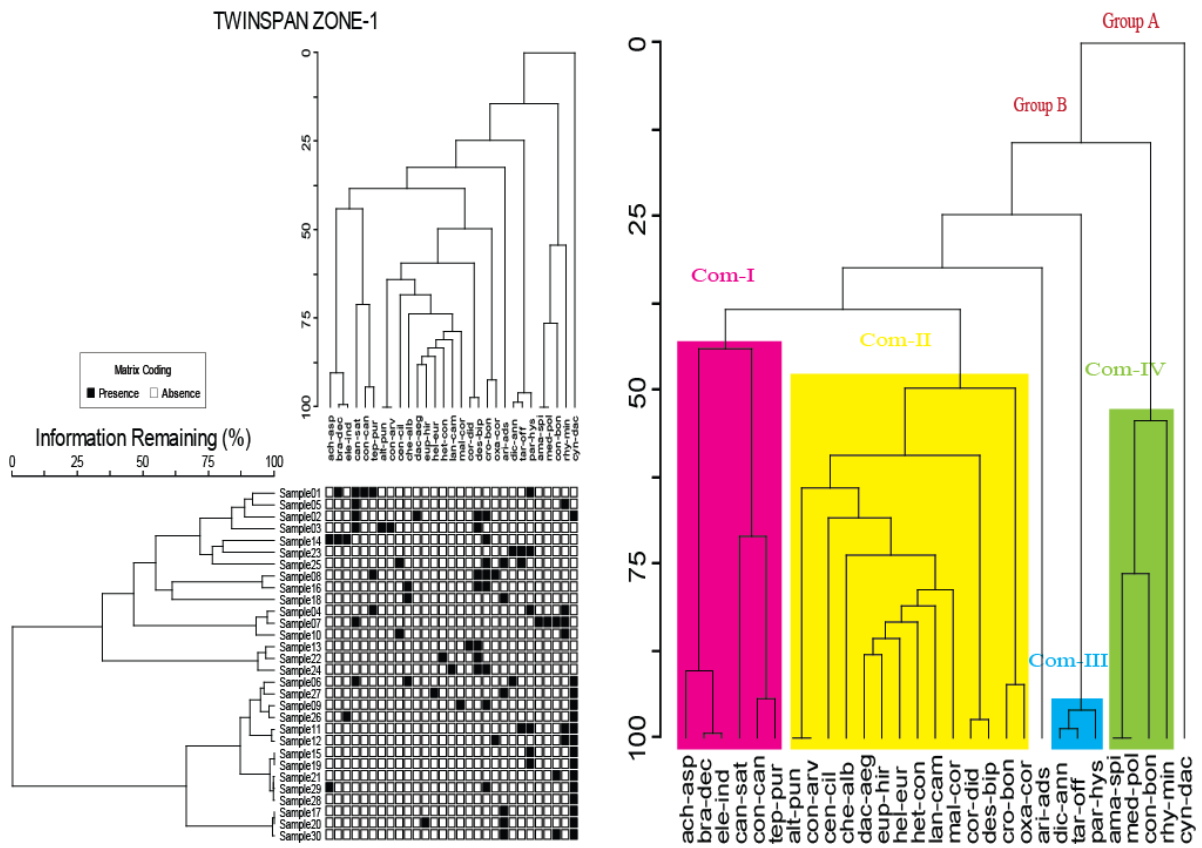


Fig. 2. Two way cluster analysis of Mangla Dam Zone-I

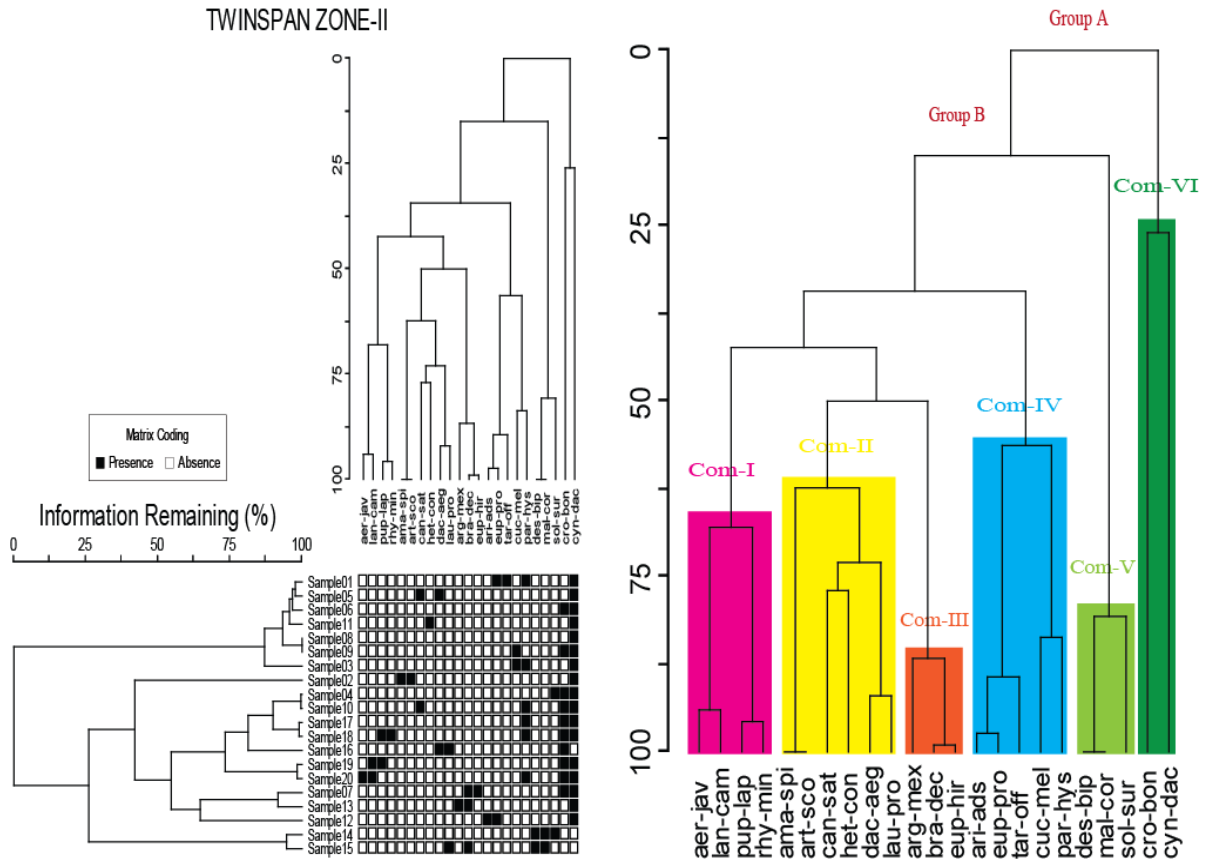


Fig. 3. Two way cluster analysis of Mangla Dam Zone-II.

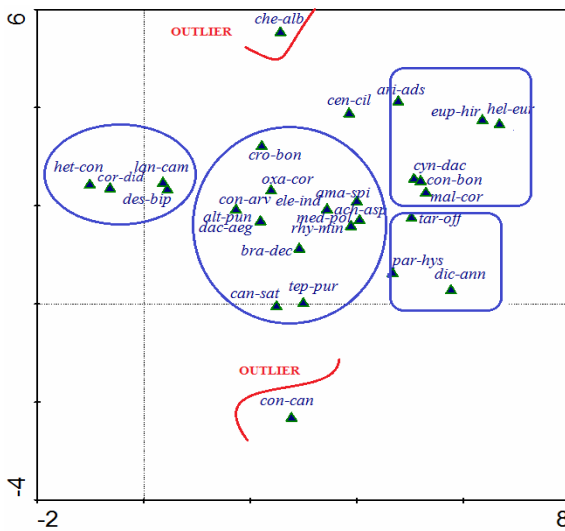


Fig. 4. DCA scatter plot of Mangla dam Zone-I

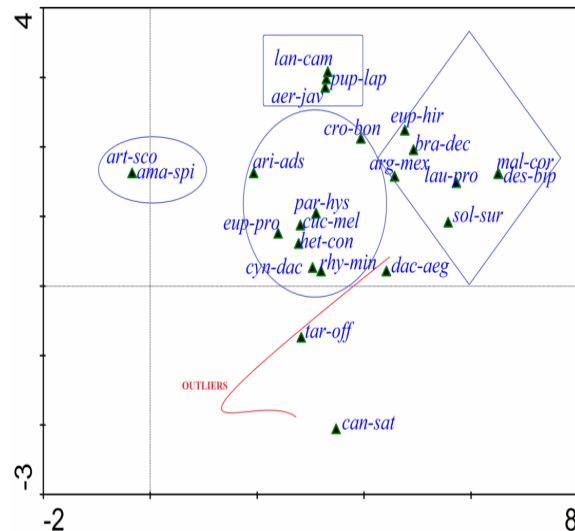


Fig. 5. DCA scatter plot of Mangla dam Zone-II

Dominance curve: Dominance curve was drawn between Rank abundance and Log sum in which species were shown on the basis of their abundance diversity at unite time. Dominance curve of Zone-I showed that *C. dactylon* was the specie in the area with higher frequency and placed at first rank in curve (Fig. 6). Whereas *D. bipinnata* showed second and *R. minima* placed at third rank following *C.*

dactylon. Two species *A. spinosus* and *M. polymorpha* were present at lower rank due to the less abundance shown by log value of sum abundance i.e. 0.698.

In Zone-II dominance curve has shown that *C. dactylon* was at the first rank due to its high frequency among all quadrats and it is most abundant and most dominant species (Fig. 7). Second most abundant and

dominant species was *C. bonplandianus*. Whereas three species *A. Mexicana*, *A. spinosus* and *T. officinalis* have minimum value of Log of Sum abundance i.e. 0.698 and placed at lowest rank in graph of dominance which was plotted between Log Sum and Rank Abundance.

NMS: Another multivariate technique NMS is most feasible methods for depicting species and associated environmental gradients in linear manner but in much reduced form. In present study NMS scree plot was drawn between stress and dimensions. Whereas stress is measure of the distance of departure from monotonicity i.e. upward trending slope. When real data lied above or within the randomized data, stress was high and data lost its monotonicity. The real data line showed that it began to level off below the value of 20 on y-axis. The leveling off the line showed the point where stress was reduced. NMS warned the stress to be reduced more than 20 i.e. group of species contained noise (Fig. 8a, 8b). Scree plot exhibited stress as purpose of dimensionality of gradient representation. Stress is an inverse measure of fit to the data. The randomized data was analyzed as a null model for comparison (McCune & Mefford, 2011).

Discussion

The present survey was conducted around Mangla Dam. The most abundant species were *C. dactylon*, *D. bipinnata*, and *R. minima* in Zone-I and *C. dactylon*, and *C. bonplandianus* in Zone-II. Ecologist uses multivariate technique for vegetation analysis as plant ecology is a branch of ecology describes species frequency or abundance on basis and adaptation to environmental gradients (Crawley, 1997). One study was done on plant classification and 22 species from 10 families were identified. Two communities were defined by using TWINSpan. It was also observed by analyzing of 50 parameters that organic matter with macro and micro nutrients played significant function in humus layer formation. Two separated clustered sites divided by TWINSpan. The first cluster included ruderal plants

while second cluster included forest and grassland species (Frouz *et al.*, 2008). Similar study was carried out on vegetation at Ayubia national park by using multivariate techniques (Ahmad & Quratulain, 2011). Total 59 species belonging to 32 families were identified. By using TWINSpan two communities were separated. Community-I had *Hedera nepalensis* and *Adiantum caudatum* while community-II composed of *Plantago major* and *Rumex nepalensis*. This study impart significant role in conservation and protection of native flora. Whereas in present study TWINSpan delineated two major groups that further divided into four sub-communities in Zone –I and six sub communities in to Zone-II. These sub groups were assigned the names of *Cannabis-Eleusine*, *Croton-Desmostachya*, *Parthenium-Taraxacum* and *Rhynchosia-Conyza* in Zone-I and *Lantana- Pupalia*, *Dactyloctenium- Launaea*, *Brachiaria- Euphorbia*, *Parthenium- Cucumis*, *Desmostachya- Malvastrum*, *Cynodon- Croton* in Zone-II. *C. sativa* could tolerate adverse environmental factors and found in 1st community under group B in Zone-I. One of the properties of *C. sativa* was that its pollens were dispersed by wind in large amount to long distances. The distribution of pollen downwind was 6 times more than it was disseminated upwind (Small & Antle, 2003). One identified species in present study was *C. sativa* which is environmentally friendly species and also use as low cost feedstock. This species has unique morphological, and require about 13 hours to grow at 6.3-6.8 optimum pH soil. Whereas most abundant specie in the area around Mangla Dam was *C. dactylon* belonged to family Poaceae. The fact of its abundance is the prevailing optimum condition like temperature above 15°C, necessary for its growth. But another fact revealed by the research that *C. dactylon* adapted in wide range of climate i.e. arid to rainy climates and did not show dormancy in any season (Ahmad *et al.*, 2014c). Some other researchers found that *C. dactylon* existed in association with *Malvastrum coromandelianum* without having preferences to a specific habitat (Ahmad, 2010).

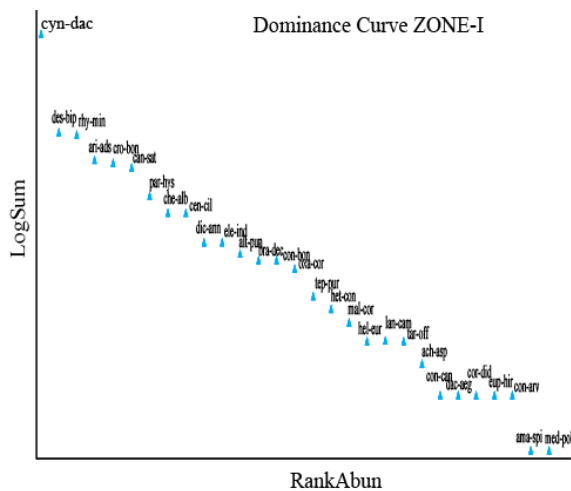


Fig. 6. Dominance curve of Mangla dam Zone-I

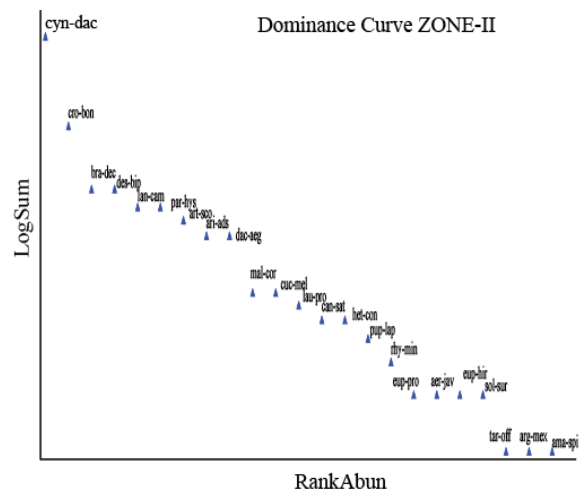


Fig. 7. Dominance curve of Mangla dam Zone-II

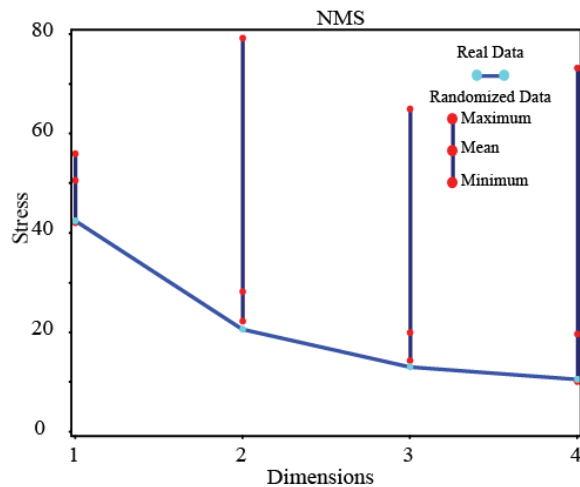


Fig. 8a. NMS scree plots of Zone-I

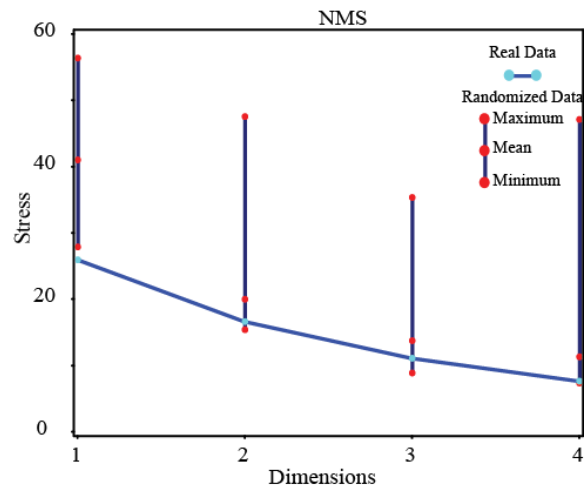


Fig. 8b. NMS scree plots of Zone-II

Conclusions

Present study was conducted to evaluate and classify herbaceous flora around Mangla dam by applying TWINSpan, DCA and NMS. Results depicted that *C. dactylon* was most abundant and regularly distributed species in both Zones of study area. NMS described and indicated the stress with respect to dimensionality about the species distribution. This study set a step forward for detail study about the vegetation in area of Mangla dam reservoir, because due to its importance as international protected area (Wetland) it is need to manage and monitor the natural resources. This study will help the decision makers to manage and improve the present condition around dam and adopt better conservation practices for species.

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