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Causal interpretation of vegetation along Nullah Korang (Islamabad, Pakistan) using multivariate techniques

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Abstract

In pursuit of elaborating the prevailing vegetation type in (Nullah Karang, Islamabad) area, phytosociology has several environmental constraints that have been overcome by statistical techniques. Vegetation was analyzed using multivariate technique along a wastewater channel (Nullah Korang) with an aim to (i) identify the prevailing vegetation type, (ii) to what extent, the existing plant species growing along Nullah Korang are in natural grouping, and (iii) causal interpretation of the existing plant communities. Field observations were recorded using quadrat method using 1m x 1m sized quadrat. Raw data was tabulated in excel spreadsheet and later on analyzed using PC-ORD for the classification and ordination analysis in which the two-way indicator species analysis (TWINSPAN) and Deterended correspondence analysis (DCA) was applied. Presently growing vegetation communities particularly *Cynodon dactylon* and *Carthamus oxyacantha* species are best adapted to prevailing environmental conditions. Three major plant communities identified in the results showed grouping of those species that share common characteristics in terms of life form and habit. It was predicted that present situation of vegetation composition will sustain in further provided no drastic environmental change or highly competitive exotic plant species intrude in the study area.

Key words: Phytosociology, multivariate technique, DCA

1. Introduction

The human impact has been a major dominating factor in affecting different aspects of earth environment. In last two centuries this impact on the earth and its resources has increased at an unprecedented rate (Bayliss and Owen, 1990). The interactions between the environment and human activities are complex, important and poorly understood. However, human activities are continuously modifying the physical, chemical and biological composition of the environment. Vegetation is a general term for the plant life of a region; it refers to the ground cover life forms, structure, spatial extent or any other specific botanical or geographic characteristics. Vegetation supports critical functions in the biosphere.

Species are not uniformly distributed over the earth. Diversity varies greatly from place to place. Different environmental factors influence the distribution of species. On a local scale on the land, the kinds of species change with soils and with changes in the topographic characteristics of slope, aspect (the direction the slope faces), elevation and relation to drainage basin (Botkin and Keller, 1995).

The analysis of species–environment relationship has always been a central issue in ecology (Antoine and Niklaus, 2000). For over a century, ecologists have attempted to determine the factors that control plant species distribution and variation in vegetation composition (Glenn *et al*., 2002). In a similar studies plant communities were sampled in the lower reaches of the Tarim River, Xinjiang. The results showed that there are 23 species belonging to 21 genera in 11 families, most of which have low occurrence frequency in quadrats. Quantitative classification (TWINSPAN) and ordination (CCA) methods were used to study the distribution patterns of 23 plant species in 19 sites in this valley. TWINSPAN results showed that the plant communities in the middle reaches of the Tarim River could be divided into 3 groups and the sampling sites could be divided into 7 types in 3 groups (Zhang *et al*., 2006). Classification of vegetation Farasan Islands using TWIN SPAN technique resulted in recognition of seven community types associated with seven different habitat types. These communities were dominated or co-dominated by 13

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perennial species; 87 associate species were recorded in the study area with chamaephytes dominating the life-form spectrum. Canonical Correspondence analysis indicated that organic carbon, soil moisture, silt, electrical conductivity and calcium carbonate were the major edaphic gradient controlling the distribution of plant communities on Farasan Islands (El-Demerdash, 1996).

Nullah Kurang is a stream of polluted water passing through Khanna Dak, Islamabad. It was contaminated by chemicals and heavy metals .Waste water from BaniGala, Bhara Kahu, Malpur and Noorpur Shahan Flows into Rawal Lake. Rawal Lake empties into Nullah Korang. From there the streams continue its way and flows along the left side of Islamabad Highway. The objective of present study was to classify the vegetation along the sides of Nullah Korang, Islamabad.

2. Material and method

The vegetation sampling was conducted from March 2008 to June 2008. The site was visited several times during this period. Unidentified plants in the field were collected and identified. Nomenclature of plants follows that of ''Flora of Pakistan'' (Stewart, 1972). Based on the usual observations of vegetation structure, which comprises mostly of herbs and grasses the quadrat size of 1m x 1m was selected. The accessible drain is 1.5 km long. Samples were taken from both sides of drain. A total of 20 quadrats were taken for herbs and grasses. Sample no. 1-10 belongs to Site A (Left side of Nullah Korang) and Sample no. 11-20 belongs to Site B (Right side of Nullah Korang). Cover was estimated as a percentage (Kent and Coker, 1992). Vegetation was analyzed using classification and ordination methods such as the Two-Way INdicator SPecies Analysis (TWINSPAN) and Deterended Correspondence Analysis (DCA).

3. Results

The vegetation at site A was dominated by *Cynodon dactylon, Carthamus oxyacantha, Zizypus jujuba, Ricinus communis, Achyranthes aspera, Poa aratica, Parthenium hysterophorus, Euphorbia helioscopia,* and *Capsella bursa-pastoris.*The diagnostic species of site B were *Euphorbia helioscopia, Rumex nepalensis, Parthenium hysterophorus, Achyranthes aspera, Cynodon dactylon, Artemisia scoparia*and, *Carthamus oxyacantha.* Due to lack of statistical analysis, understanding the structure of plant species is associated with considerable mistakes, therefore, vegetation of the study area was classified using DCA analysis. All the default settings of the computer program PC-ORD for windows version 5 were used for DCA. These results clearly indicated that vegetation of whole study area into two major communities, which were further divided into sub-communities. Each community was named after the leading dominant species. Each community differs from the others in its environmental attributes.

Communities identified by DCA along site A.

At site A, following major plant species groups were identified figure 1.

1. *Carthamus oxyacantha, Achyranthes aspera, Broussonetia papyrifera*.
2. *Parthenium hysterophorus, Artemisia scoparia, Plantago major Cynodon dactylon, Rumex nepalensis, Capsella bursa-pastoris.*
3. *Poa aratica, Taraxacum officinale, Phalaris minor* community.

3.1. *Carthamus oxyacantha, Achyranthes aspera, Broussonetia papyrifera*.

The species present in this group includes *Carthamus oxyacantha, Broussonetia papyrifera* and *Achyranthes aspera*. Diagnostic species of this group was *Carthamus oxyacautha,* which had a cover value of 25%. *Achyranthes aspera* was the co-dominant species, having a cover value of 16%.Both of these species are herbs. *Broussonetia papyrifera* was the only tree species in this group and was the least occurring species of the group.

3.2. Parthenium hysterophorus, Artemisia scoparia, Plantago major.

The species present in this group were *Parthenium hysterophorus, Artemisia scoparia* and *Plantago major*. *Parthenium hysterophorus* of family Asteraceae is the dominant species in this group, with a cover value of 11%. *Artemisia scoparia,* with a cover value of 8% was the co-dominant species. The least occurring species in this group was *Plantago major,* which had a cover value of only 4%. Destructive human activities result in low species count at this side.

3.3. *Cynodon dactylon, Rumex nepalensis, Capsella bursa-pastoris.*

The diagnostic species of the group was *Cynodon dactylon* of family Poaceae with the cover value of 19.7 %. *Cynodon dactylon* occurs on almost all soil types. It was common in disturbed areas such as gardens, roadsides, overgrazed, trampled areas, uncultivated lands, localities with high levels of nitrogen, and is often found in moist sites

along rivers (Martin et al., 1951). *Capsella bursa-pastoris* was co-dominant species in the group. It had a cover value of 11%. *Rumex nepalensis*, had a cover value of 8% is least occurring species of the group.

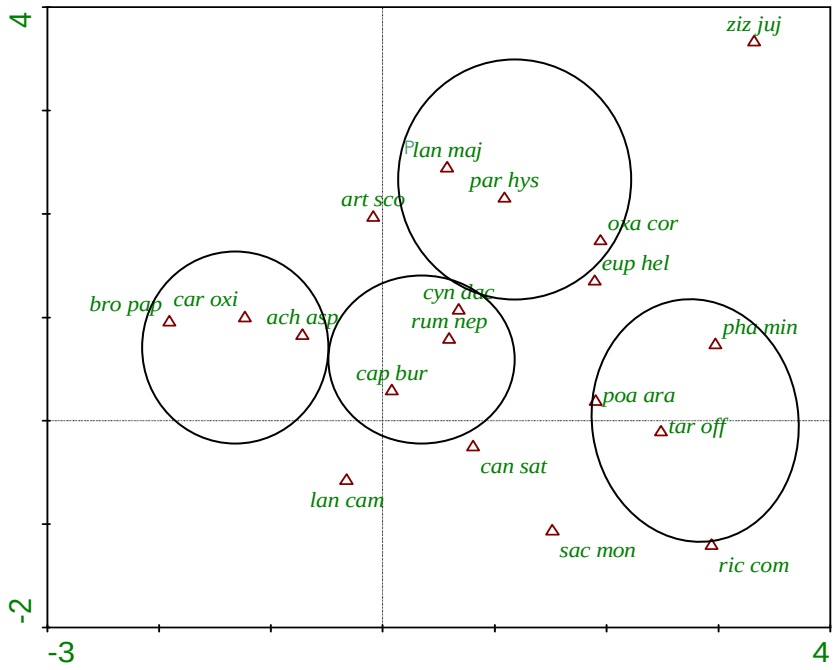

Figure 1. Scattered diagram showing grouping of species at site A

3.4. *Poa aratica, Taraxacum officinale, Phalaris minor.*

Poa aratica, with a cover value of 13% was the dominant species of this group. The co-dominant species of this group was *Taraxacum officinale*, with a cover value of 6%. *Phalaris minor* was the least occurring species of this group. It had a cover value of only 4%.At the site A only four groups, each comprising of three species were identified by DCA. There are very few species found in these groups. Low species count was due human anthropogenic activities at this site. Land had been cleared for agricultural purposes at this side. These practices resulted in destruction of natured flora at this site.

Communities identified by DCA along site B.

At site B, following major plant species groups were identified figure 2.

- *Achyranthes aspera, Anagallis arvensis* community.
- *Euphorbia helioscopia, Cannabis sativa* community.
- *Rumex nepalensis, Lantana camara community.*
- *Cynodon dactylon, Lantana camara* community.

3.5 *Achyranthes aspera, Anagallis arvensis* community

The species present in this community were *Achranthes aspera, Anagallas arvensis* and *Polygonum plebejum*. The community was named after dominant species. The dominant species of the group was *Achranthus aspera*, with a cover value of 18%. *Anagallis arvensis* had a cover value of 8% and was the co- dominant species. *Polygonum plebejum*, with a 6% cover value was the least occurring species.

3.6. *Euphorbia helioscopia, Cannabis sativa* community

This community was dominated by *Euphorbia helioscopia*, with a cover value of 16%. *Cannabis sativa*, with a cover value of 8% was the co- dominant species of the community. The other species recorded in the groups were *Zizypus jujuba*, 4% and *Hytopogon contlathus*.

3.7. *Rumex nepalensis, Lantana camara* community

This community was characterized by three species. *Rumex nepalensis* had the largest cover value, 11%, so it was the dominant species of community. The other species of the group were *Capsella bursa-pastoris* (9%) and *Lantana camara*, with a cover value of 6% was the least occurring species of the group.

3.8. *Cynodon dactylon, Lantana camara* community

Cynodon dactylon of family Poaceae, the most dominant species of the group. It has a cover value of 27%. *Plantago major* was the co- dominant species of the group. It had a cover value of 6%. The other species of the group were *Chenopodium alba*, *Dalbergia sissoo*, *Riccinus communis* and *Saccharum munja*.

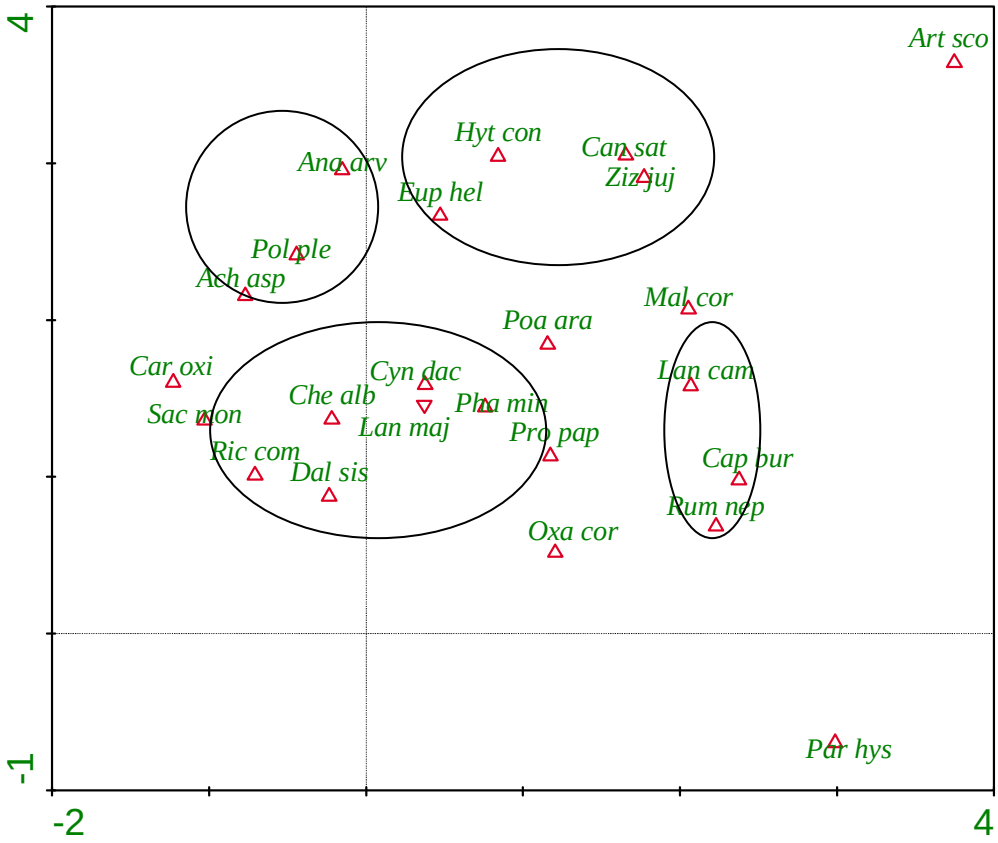

Figure 2. A Scattered diagram showing grouping of species at site B

4. Conclusions and Discussion

In the present study, an overall low species count was observed due to urbanization effects and human anthropogenic activities in the study area. Although 20 quadrats were recorded at both sides of Nullah Korang (A and B), but less number of species indicate that plant diversity is on decline, reflecting an important indicators of quality of life (Knops *et al*., 1999). Prediction of distribution of species requires good survey data as well as knowledge of environmental factors (Le Duc *et al*., 1992), therefore, vegetation along Nullah Korang not only showed few dominant species comprising the associations and distinct communities, but our results also showed some trends of habitat fragmentation. Our effort in this study was to include all plants, the habitats in which they are found, their interactions with each other and with other organisms. This has enabled us to highlight important trends of vegetation composition as species composition is strongly influenced with their surroundings and the genetic differences between them (Knops et al., 1999). Species are not uniformly distributed over the earth. Diversity varies greatly from place to place (Botkin and Keller, 1995). As a whole our study is based on the results of field quadrats observation where only 25 species were recorded. Usually this norm is followed in similar type of studies where vegetation in the filed is analyzed directly from quadrat method and then synthetic information was derived through raw data by arranging the quadrats in proper order (Cillers and Bredenkamp, 1999). At site A, *Cynodon dactylon* with a cover value of 38% was the most dominant species. *Carthamus oxiacantha* was the co-dominant species at this site. It had a cover value of 25%. At site B, *Cynodon dactylon* was the most dominant species. The persistent dominance of *Cynodon dactylon* on both the sites can be explained on the basis plant habit as this grass species tend to be herbaceous and requires relatively more soil moisture to grow. As this study was conducted along Nullah Korang therefore, availability of soil moisture was adequat and no limitation factor of that kind has existed in the study area and hence naturally favoured the colonization of this grass species persistently in site A and B. Due to this reason probably it constituted a cover value of 28%. On the other hand *Euphorbia helioscopia* having a cover value of 16% was the co-dominant species. A major factor in the appearance of these two species as dominant one and co-dominant may seem to be the similarity of habit and life form as both were herbaceous. In addition to that, grouping of plant species as revealed in DCA biplots further strongly

support this evidence that plant sharing the same ecological requirements have been found in close vicinity. Wilson et al. (1998) gave a similar illustration that small scale vegetation dynamics evolve where common characteristics among plants led them to grow in close vicinity. The study though based on small scale but it seems to be influenced by several characteristics and this has been reported that regional scale vegetation dynamics is generally influenced by several characteristics of biotic and abiotic origin (Noe and Zedler, 2001). In a similar study carried out by Ahmad et al (2009) and lu *et al*. (2006) multivariate techniques was used to classify vegetation and discover a correlation with environmental variables.

The Nullah Korang has a continuous water flow maintained throughout the year. However, in rainy season, particularly in monsoon, the amount of water overflows at certain spot thus making the adjacent soil under water. This makes an interesting condition to cause variations among new colonizing annual species. The communities grouped in TWINSPAN revealed this fact as most of the annual species were naturally grouped. Such trends are highlighted in other studies as well (Wilson et al., 1998) and temporal variation in vegetation composition can be explained better on such trend (Le Duc et al., 1992). Ahmad (2007) classifies the wild medicinal flora of (M-2) Pakistan on the basis of their medicinal importance. In conclusion, it seems that present conditions will remain sustainable provided no outside disturbance influence the vegetation to change. Furthermore, the environmental conditions of areas along Nullah Korang will remain supportive and favour the dominance of currently growing plant species so long as any exotic intruder successfully colonize the area and outperform other species in competition.

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