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DETRENDED CORRESPONDENCE ANALYSIS OF VEGETATION ALONG MOTORWAY (M-2), PAKISTAN

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Abstract

Road verges are identified as natural habitat to conserve the native flora and provide the basic environment for the growth of indigenous flora. For this purpose a field survey was carried out along the road verges of motorway (M-2). The road verges data collected along the road verges was analysed using ordination technique, DECORANA, computer programme in order to classify the data. Deterended Correspondence Analysis (DCA) identifies clusters of species in ordinate space and verifies groups of species. The road verges data was collected from 397 quadrats and 227 vascular plants species belonging to 75 families were recorded. DCA eigenvalues for the first two axes were 0.59 and 0.46. These values suggest a good dispersion of data along the axes. However, scatter diagram is more easily interpretable in ecological terms. A total of four communities were identified which differs mainly on the basis of their ecological amplitudes. This data will be used as initial source data which can be used to study the successional changes in future with reference to different environmental conditions.

Introduction

Transport, both domestic and international, becomes increasingly important as economies develop, since trade tends to grow faster than production. Therefore, road reconstruction is one of the strategic priorities of the economic, social and political development in every country (Dierkes & Geiger, 1999).

Roadside vegetation has been documented by many workers in different countries (Holzapfel & Schmidt, 1990; Hussey, 1991; Tyser & Worley, 1992; Wilson *et al.*, 1992; Ahmad *et al*., 2009 & Pirzada *et al*., 2009). These studies are mostly confined to a specific road or the roads of a specific region. Some useful studies of roadside flora on national level have been carried out put by Hansen & Jansen (1972) in Denmark & Danin (1991) in Israel. The present study demonstrates the floristic survey of road verges alongside motorway and mainly focuses on identification of vegetation species and highlighting the importance of roadside verges as ecological habitats. The information solicited from these studies would help in furthering our knowledge of the ecological implications of man-made ecosystems, the dynamics of environmental processes and changes such as succession and nature conservation. In addition, this information will serve as baseline information for comparison in future.

Methodology: DCA(Deterended Correspondence Analysis) was conducted to investigate the relationship among vegetation types (Hill & Gauch, 1980). Information was collected about M-2 i.e., the study area through map provided by Pakistan Motorway. Basing upon maps, a reconnaissance survey of M-2 was carried out in different seasons during 2005 to familiarize with the study area and its roadside vegetation.

Selection of sites: The total number of sampled stands is 50 and comprises of 397 quadrats (1 x $2m^2$). In the selected sites plot were located after every 7km intervals and only those sites were selected which has a large cover of vegetation along the verges. During site selection the disturbed roadsides (vehicle accidental area, fire effected area, oil leaked area etc**)** were avoided. While selecting the site it was kept in mind that it would cover different aspects of road such as verge size, topography.

Zonation of road verges: M-2 roadside was divided into two different zones i.e., border zone and verge zone. Border zone include the shoulder of the road while verge zone include adjacent road reserve that is demarcated from the adjacent private or state owned land by a fence. The whole study is also divided into three regions i.e., Region I, II & III.

Plant data collection: The vegetation data was collected by using the visual estimation of cover value as describe by Kent & Coker (1995). According to this approach, sampling was done by the use of quadrats, which are vegetation samples that are not randomly located and carefully selected as representative area of a vegetation type.

Size of quadrats: Based on the usual observations of vegetation structure, the quadrat size of 1 x $2m^2$ was selected. A 100-meter long tape was laid down parallel to road randomly in each zone of the verge at each site. One quadrat of 1 x $2m^2$ was selected at the start of long laid tape as border zone and second at last point of border zone. Two quadrats were laid along tape in verge zone. The same method was applied on both sides of road.

Results and Discussion

Species groups constructed with tabular methods were corroborated with Deterended correspondence analysis (DCA), which identifies clusters of species in ordinate space and verifies groups of species. A DCA analysis of all the plots maintained a coherency with vegetation types.

Two scatter diagrams have been used in an attempt to show the relationships and gradients between the different communities and to establish any correlation between them. In the first diagram (Fig. 1), the distribution of all the quadrats along the first and second ordination axes is given. DCA eigenvalues for the first two axes were 0.59 and 0.46. These values suggest a good dispersion of data along the axes. However, scatter diagram is easily interpretable in ecological terms. This diagram illustrates a gradient along ordination axis 1 which could be related to low temperature and high rainfall on the left to high temperature and low rainfall on the right. The gradients on the ordination axes 2 could be related to specific habitat conditions with hot and dry habitats at the top and relatively cooler and moister habitats towards the bottom.

Out of the four major communities, community number 1 comprises of quadrats which occurred mostly in highly disturbed areas i.e., around Chakri interchange from Rawalpindi and after Sheikhupura interchange towards Lahore, at the start and at the end of study area, i.e. before and after main toll collecting booths. These areas show to some extent breakage of fence and intrusion of disturbing factors. The amount of moisture available and temperature were quite favourable, but this community remained smaller in size due to disturbance in habitats from broken fence.

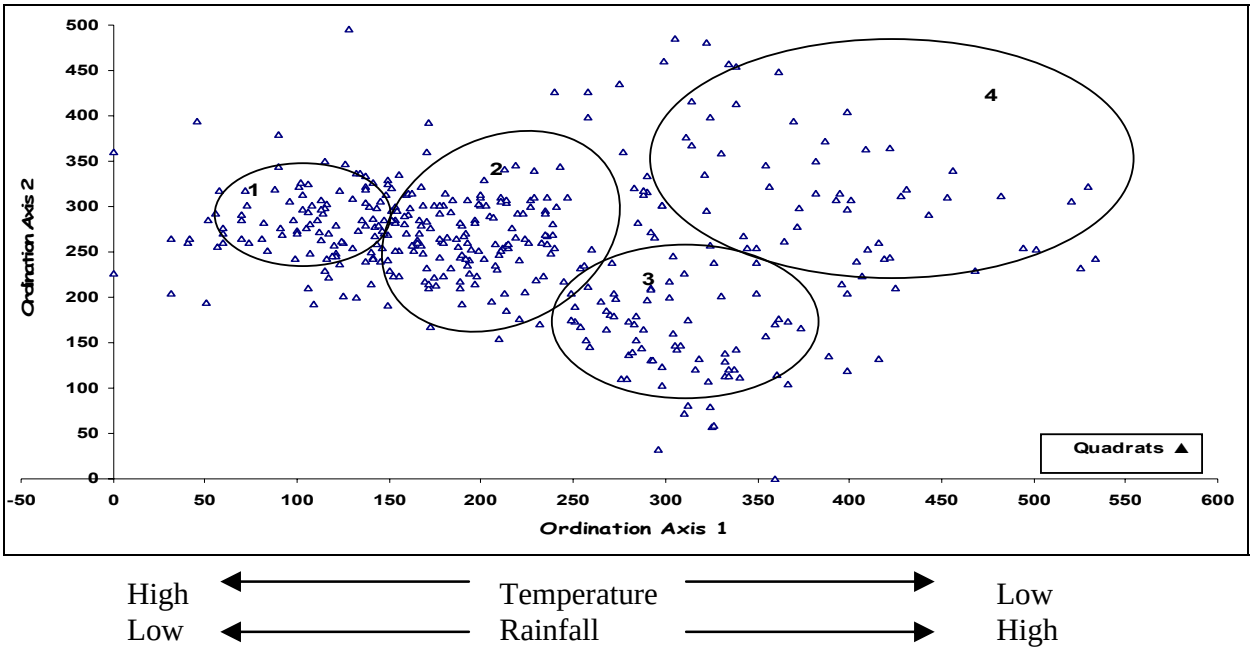

Fig. 1. Deterended Correspondence Analyses (DCA) of quadrats.

The community number 2, which was the major and largest community, showed its appearance in quadrats mostly present in Kallar Kahar and Salt Range areas. These areas seemed to be highly favourable for the flora as indicated by the occurrence of maximum number of species in Region II. This area i.e., Region II was present in between a relatively cool Region I and comparatively hot Region III i.e., towards Lahore. Therefore the Region II was regarded as a moderate climate area. The further division of communities was not so illustrative. Similar studies were conducted by Ahmad & Hussain (2008), along the road verges of Kallar Kahar area of salt range and Ahmad *et.al.* (2009) along road verges of Abbottabad city.

The community number 3 comprises of quadrats, which were quite dispersed showing high axes 1 score and low axes two scores. Majority of these quadrats occurred in the Region III of the study area, which was marked with relatively high temperature and low rainfall as compared to whole study area. This community, though divided into sub communities, but number of species in the sub community were quite few.

Community 4 showed highly scattered quadrats. These quadrats were on the highest scores of axes 1 and 2. Though these quadrats were divisible into sub communities, but again the numbers of species were few in each of the sub communities. The occurrence of these quadrats on highest side of axes 2 indicates a quite hot and dry habitat loving species in these quadrats. Concisely the communities 1 and 2 represent study area Region I and II, whereas communities 3 and 4 represent study area Region III.

From the total number of 227 species recorded in 397 quadrats of the study area, DCA scattered diagram of species (based on the species score) was made. This illustrates the position of each species along the two axes and their relationship with the gradients (Fig. 2). The occurrence of *Achyranthes aspera*, *Euphorbia hirta*, *Sonchus asper*, *Cenchrus ciliaris, Convolvulus arvensis,* and *Oxalis corniculata* on the extremely right side of species score in ordination diagram indicates their high axes 2 scores and low axes 1 scores. These high scores of axes 2 portray the preferences of these species' relatively dry and hot habitats. Similarly their clustering together also shows their degree of similarity i.e., they require more or less same microclimatic conditions.

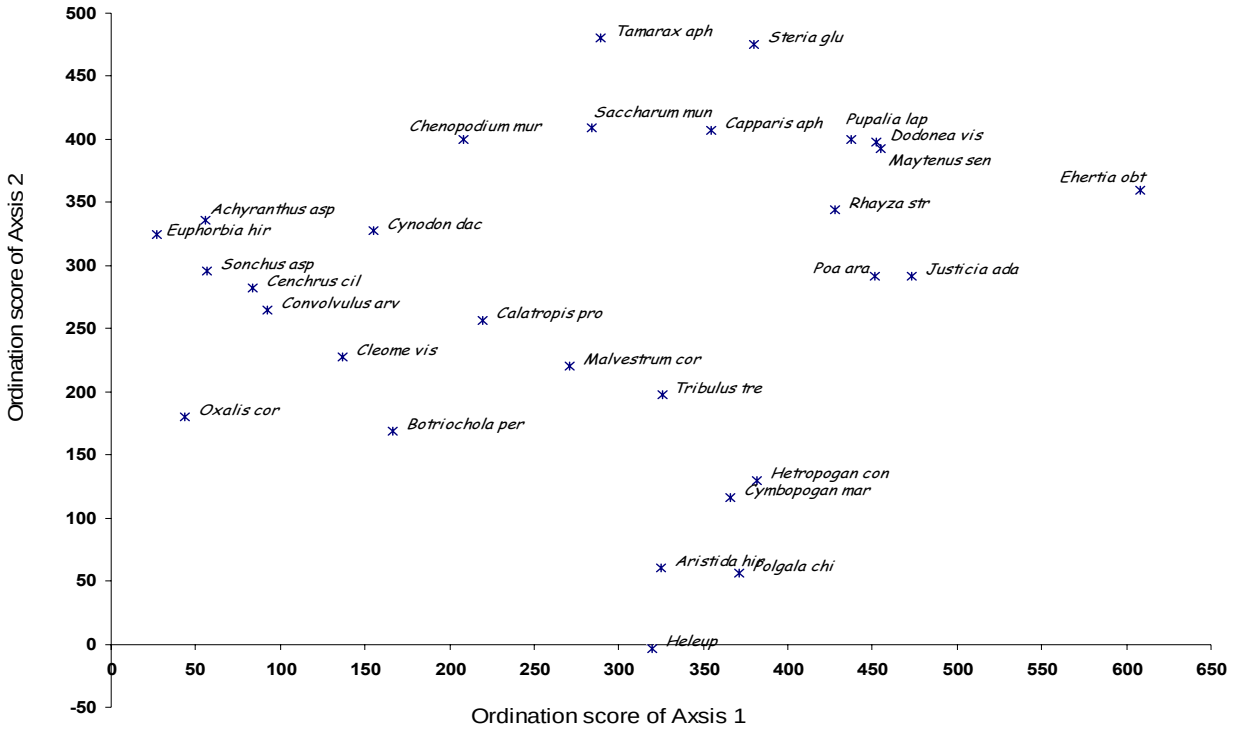

Fig. 2. DCA of sub community's representatives.

The presence of *Tamarix aphylla, Setaria glauca, Chenopodium murale, Saccharum munja, Capparis aphylla, Pupalia lappacea, Dodonea viscosa, Mayetenus senegalensis* and *Ehretia obtusifolia* on the top of axes 2 (high axes 2 scores) showed their preference for comparatively hot and dry climate area and similarly their axes 1 scores were also quite high indicating that they exist in an area of low rainfall and high temperatures. The species present at the top comprise of tree, shrubs, and herbs showing ecological amplitude to survive in comparatively hot and dry conditions. The clustering together of large tufted grass *Saccharum*, evergreen *Dodonea*, prostate herb *Pupalia lappacea*, *Capparis aphylla* and *Mayetenus* shows that they all to some extent were grouped together due to their same ecological amplitude.

Occurrence of *Heteropogon contortus*, *Cymbopogon martini*, *Aristida hirta*, and *Polygala chinensis* on lower side of axes 2 indicate their preferences for comparatively cool and area of better rainfall. Values of axis 1 showed their transitional occurrence in central Region; whereas negative values of axes 1 for *Heliotropium europaeum* indicate its ecological properties like loving hot, dry and disturbed areas (www.weedman. horsham.net.au/index.htm). The weedy species showed restricted occurrence in few habitats suitable for its microclimatic conditions.

Ehretia obtusifolia shows maximum axes 1 score indicating its suitability of occurrence in hot, dry and area of low rainfall. Along with that *Rhyaza stricta, Poa araratica,* and *Justicia adhatoda* show high axes 1 score and were clustered together indicating their similarity in ecological requirements.

The occurrence of *Cynodon dactylon, Cleome viscosa, Calotropis procera, Malvastrum coromandelianum, Bothriochola pertusa and Tribulus terrestris* in the center of scattered diagram indicates a lack of preferences of these species to the specific habitat conditions. Moreover most of these species were ubiquitous in nature and showed their occurrence in most of communities and sub communities. Along with that the scattered diagram also indicates that these species were present at same distance from each other, but due to ecological amplitude they were grouped together in sub communities.

The pattern of plant distribution on the road verges shows that in general, roadside plant species can be divided into two large groups: mainly present on the border zone (I &III); present on the verge zone (II&IV). While investigating the vegetational composition in different Regions, i.e., Region I, Region II and Region III, it was found that there was a significant difference between the frequencies of species in each Region. However only two species have been found to have frequencies in excess of 50% i.e., *Calotropis procera* and *Cynodon dactylon*. Among them *Cynodon dactylon* even attained a maximum of 70.1%. Hansen & Jansen (1972) while studying the vegetation on roadsides in Denmark also recorded such high frequency of dominating species. Ali *et al*., (2004) also recorded *Cynodon dactylon* to be a major dominating species in different areas of the Punjab, Pakistan. This study also supports the previous study calling for the recognition of the botanical importance of the roadside verges (Way, 1977).

References

Ahmad, S.S. and S.Z.Husain. 2008. Ethno medicinal survey of plants from salt range (Kallar Kahar) of Pakistan. *Pakistan Journal of Botany*, 40(3): 1005-1011.

Ahmad, S.S., S. Fazal. E.E. Waleem and I. Zafar. 2009. Evaluation of ecological aspects of roadside vegetation around Havalian city using multivariate techniques. *Pakistan Journal of Botany*, 41(1): 461-466.

Ahmad, S.S., S. Fazal. E.E. Waleem and I. Zafar. 2009. Evaluation of ecological aspects of roadside vegetation around Havalian city using multivariate techniques. *Pakistan Journal of Botany*, 41(1): 461-466.

Ali, M., T. Ahmad and A. Rashid. 2004. Phytosociological synthesis as inferred from soil: analysis of some industrial areas of Punjab, *Asian Journal of Plant Sciences*, 3: 320-324.

Danin, A. 1991. Roadside Vegetation in Israel. *Urban Ecology*, (Ed.): M.A. Ozturk, pp. 392-403. Ege University Press, Turkey.

Dierkes, C. and W.F. Geiger. 1999. Pollution retention capacities of roadside soils. *Water Sci. Technol.*, 39: 201-208.

Hansen, K. and J. Jansen. 1972. The vegetation of roadsides in Denmark. *Dansk. Bot. Arkiv*, 28, 1-59.

Hill, M.O. and H.G. Gauch. 1980. Detrended Correspondence Analysis, an improved ordination technique, *Vegetation*, 42: 47-58.

Holzapfel, C. and W. Schmidt. 1990. Roadside vegetation along transects in Judean desert. *Israel journal of Botany*, 39: 263-270.

Hussey, B.M.J. 1991. The flora road survey: Voluntary recording of roadside vegetation in Western Australia. *Nature Conservation 2: The Role of Corridors*, (Eds.): D.A Saunders & R.A. Hobbs, pp. 41-48. Surrey Beatty & sons, Chippon Norton, Australia.

Kent, M. and P. Coker. 1992. *Vegetation description and analysis*, 1st ed. Belhaven Press, London.

Pirzada, H., S.S. Ahmad and R. Audil. 2009. Monitoring of soil lead pollution using roadside plants (*Dalbergia sissoo* and *Cannabis sativa*) utilizing multivariate analysis. *Pakistan Journal of Botany*, 41(4): 1729-1736.

Steiner, N.C. and W. Kohler. 2003 Effects of landscape pattern on species richness-a modeling approach. *Agriculture, Ecosystem and Environment*, 98: 353-361.

Tyser, R.W. and C.A. Worley. 1992. Alien flora in grasslands adjacent to road and trail corridors in Glacier national park, Montana, USA. *Conservation Biology*, 6: 257-282.

Way, J.M. 1977. Roadside verges and conservation in Britain: a review. *Biological Conservation*, 12: 65-74.

Wilson, J.B., G.L. Rapson, M.T. Sykes, A.J. Watkins and P.A. Williams. 1992. Distribution and climatic correlations of some exotic species along roadsides in South Ireland, New Zealand. *J. Biogeography*, 19: 183-194.

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