Pak. J. Bot., 42(3): 1745-1754, 2010.

THE HUDIARA DRAIN WASTEWATER EFFECT ON THE DISTRIBUTION OF SURROUNDING HERBACEOUS VEGETATION

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Abstract

In this study, phytosociological survey using Braun-Blanquet's approach was undertaken to investigate the Hudiara drain wastewater influence on the surrounding vegetation. A total of 99 quadrats were laid to identify the plant species and altogether 66 species were recorded. Multivariate analysis of vegetation data (using CANOCO 4.5. software) classified the vegetation into two major communities including *Cynodon dactylon*, *Boerhaavia diffusa*, *Parthenium hysterphorus* and *Xanthium strumarium* groups*.* The presence of these species designated the area as waste land strongly supporting the growth of such species. The pattern of floral diversity was also not uniform and exhibited considerable variation. Canonical Correspondence Analysis revealed that the distribution of vegetation has correlation with environmental variables, but their role in the grouping of species remained non significant. However, soil EC played some role in the grouping of *Stellaria media* and *Fagonia cretic.* Similarly, some species viz., *Ricinus communis*, *Boerhaavia diffusa* and *Phragmites karka* showed a correlation with Fe and Cr respectively, suggesting *Phragmites karka* as a suitable candidate for chromium contaminated sites.

Introduction

Plant communities are dynamic entities undergoing continuous change in response to climate, land use patterns and dynamics of the community and their inventories provide a baseline data to determine changes in the communities (Yeaton, 1978). The most commonly used data mainly rely on abundance or importance of taxa (usually species) indexed by sampling units e.g., quadrats, releves, stands, traps etc. Such data are typically organized in matrix with species as rows, sampling units as columns and abundance as the entries. Vegetation analysis, like quantitative techniques in other disciplines, has undergone a temporal scrutiny somewhat analogous to natural selection. Species groups have typically been constructed using combinations of field observations, inspection of tabular species site matrices, and multivariate analysis such as cluster analysis (Godart, 1989; Kashian *et al*., 2003). Similarly, Two Way Indictor Species Analysis (TWINSPAN) mainly involves species cover (%) to classify vegetation into groups (Hill, 1979).

The correlation between vegetation and its corresponding environmental parameters provides guidelines for understanding plant species composition and structure in a particular habitat, landscape and region (Munica, 1997). Attempts have been made to determine the factors that control plant species distribution and variation in vegetation composition (Glenn *et al*., 2002). Canonical Correspondence Analysis (CCA) utilizes both vegetation and environmental data in order to determine relationship between species composition and measured environmental variables. It mathematically defines canonical axes, and produces diagrams of sample points and plant species plotted in relation to those axes (Palmer, 1993).

Soil is also considered an important component of ecosystem because it provides medium for plant growth, supplies water, nutrients in addition to providing a supporting environment (Craul, 1992). The nature of the soil is characterized by several physical, chemical and biological properties (Russel, 1973). The metal ions (Mg, Fe, Co, Ni, Cu, Zn and Mo) are essential for plant and play a variety of functions in biological systems (Sial *et al*., 2006). Likewise soil pH is another important factor for determining the interactions between plants and soils (Dahiys *et al*., 1984).

Hudiara drain is one of the main tributaries of the river Ravi. Its discharge at source R.D. (138) is 73.3 $m^3s^{-1}$and at outfall R.D. (308) is 141.2 m^3s^{-1}. Over 120 industrial units of variegated nature are presently discharging their untreated effluents into it in addition to the influx of sewage water of some localities of metropolitan Lahore, which has ultimately adversely affected the natural flora of the area (Rashid & Majeed, 2002). The present study demonstrates a floristic survey along the Hudiara drain with the special emphasis on the identification of vegetation species and the importance of the drain as ecological habitats. The information solicited from the study would help advance our knowledge about the ecological implications of the dynamics of environmental processes and changes such as succession and nature of conservation.

Materials and Methods

Phytosociological survey along the Hudiara drain was carried out during spring 2008. A well recognized approach after Braun-Blanquet (Braun, 1932) was used to collect vegetation data establishing quadrats, which were carefully laid in representative area of vegetation type. A rectangle shaped quadrat (2 x 0.5 m) was used for sampling of vegetation because of linear nature of habitat. To assess the magnitude of drain wastewater effect on the vegetation of each sampling site, three quadrats were laid at each sampling site. First quadrat was laid at 0.3-1m distance from drain bank, second one at a distance of 5-10m, whereas third quadrat was at 10-15m away from first quadrat. Vegetation (predominantly of herbs and grasses) data was recorded by visual estimation using cover scale (Kent & Coker, 1992). A total of 99 quadrats were laid for the sampling of vegetation at 33 sites along the drain (Fig. 1). Plant nomenclature was followed from the Flora of Pakistan (Nasir & Ali, 1971-1995 and Ali & Qaisar, 1995-2008). Multivariate analysis of vegetation data was carried out using CANOCO 4.5 software.

A 10-15 cm top soil layer was sampled using stainless steel trowel because plant nutrients are predominantly present in this zone (Allen, 1989). Soil samples were prepared for laboratory analysis (pH, EC, OM, metal elements) following standard procedures. Soil pH was determined using pH meter (212, HANNA, Sarmeola-di-rubno, Italy). The electrical conductivity (EC) of soil was measured with a CD 2002 EC meter (Selecta, Barcelona, Spain) after taking the saturation extract of soil with rotary vane vacuum pump (Vacuu brand- GmbH, Germany). Soil organic matter (OM) and extractable phosphorus (P) was determined using a UV/Vis Spectrometer (Lambda 25, Perkin Elmer, Shelton, CT, USA). Sodium (Na) and potassium (K) ions in soil were determined using Flame photometer (PFP-7, Essex, England). Diethylenetriaminepentaacetic acid (DTPA) extractable micro and macro nutrients were determined using flame atomic absorption spectrophotometer (FAA) (Spectra 250 Plus, Varian, Mulgrave, Victoria, Australia) following the method after Lindsay & Norvell (1978).

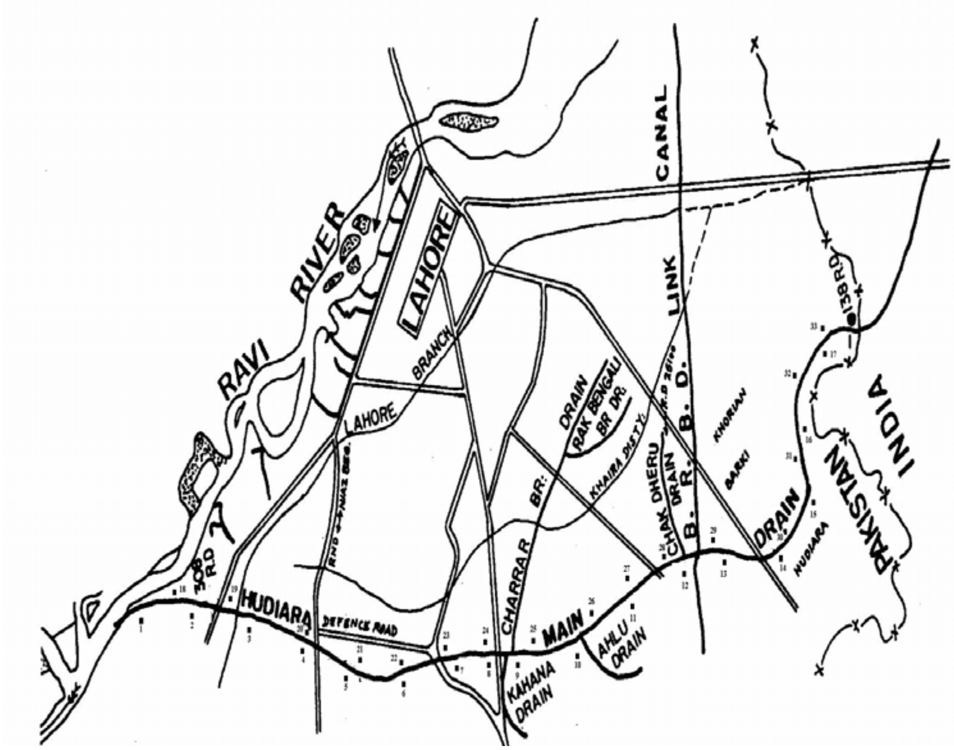

Fig. 1. Location Map of Sampling Points along the Hudiara Drain.

Results and Discussion

A total of 66 vascular plant species from 24 families were recorded in the 99 quadrats during the survey of the area (Table 1), which showed drain surroundings an important habitat for local flora. Despite the presence of such a number of species (66 species), most species exhibited low presence value and only five have frequency >20% while 23 species were present in more than 5 quadrats (frequency >5%) indicating a heterogeneous situation (Table 2). *Cynodon dactylon, Parthenium hysterophorus, Xanthium strumarium, Desmostachya bipinnata* and *Cyperus rotundus* are the most frequent species and dominate the area. Beside these *Calotropis procera, Achyranthes aspera, Suaeda fruticosa, Chenopodium album* and *Cenchrus ciliaris annulatum, Dactyloctenium aegyptium* are also the frequently present in the area which also enumerated percentage cover of each of these species calculated on the basis of whole study area. The presence of these species characterizes the area a true waste land suitable for the rapid growth of such species. Similar observations have been made in previous studies of roadside vegetation in different countries (Batanouny, 1979; Akbar, 1997; Ahmad, 2007).

Two Way Indictor Species Analysis as shown in Fig. 2 categories vegetation of the study area into two major communities, namely, community 1 and community 2.

Table 1. Species with respective families falling along the Hudiara drain.

Family	Species
Malvaceae	*Abutilon indicum*
	Malvastrum coromandelianum
	Malva neglecta
	Urena lobata
Amaranthaceae	*Amaranthus viridis*
	Chenopodium murale
	Digera arvensis
	Chenopodium album
	Achyranthes aspera
Asteraceae	*Conyza japonica*
	Xanthium strumarium
	Parthenium hysterophorus
	Ageratum conzoides
Fabaceae	*Prosopis glandulosa*
	Rhynchosia minima
	Alhaji marorum
Chenopodiaceae	*Chenopodium ambrosioides*
	Suaeda fruticosa
	Salsola foetida
	Atriplex crassifolia
Poaceae	*Cenchrus ciliaris*
	Cenchrus biflorus
	Dichanthium annulatum
	Digitaria stricta
	Digitaria nodosa
	Cynodon dactylon
	Poa annua
	Desmostachya bipinnata
	Phragmites karka
	Dactyloctenium aegyptium
	Panicum antidotale
	Paspalidium flavidum

Table 1. (Cont'd.).

Family	Species
	Saccharum spontaneum
	Saccharum munja
	Phalaris minor
	Setaria glauca
	Chrysobogon sp.
	Brachiaria ramosa
Euphorbiaceae	*Ricinus communis*
	Mercurialis perennis
	Croton glandulosus
Cucurbitaceae	*Momordica sp.*
	Cucumis prophetarum
Boraginaceae	*Heliotropium undulatum*
	Cynoglossum lanceolatum
Solanaceae	*Physalis minima*
	Solanum plumbeginifolia
	Withania somnifera
	Datura alba
Zygophyllaceae	*Tribulus terrestris*
	Fagonia cretica
Polygonaceae	*Polygonum barbatum*
	Polygonum glabrum
Caryophyllaceae	*Stellaria media*
Cannabaceae	*Cannabis sativa*
Pontederiaceae	*Eichornia crassipes*
Oxalidaceae	*Oxalis corniculata*
Brassicaceae	*Nasturtium indicum*
Phrymaceae	*Mazus rugosus*
Asclepiadaceae	*Calotropis procera*
Nyctaginaceae	*Boerhaavia diffusa*
Cyperaceae	*Cyperus rotundus*
Tamaricaeae	*Tamarix indica*
Aizoaceae	*Trianthema monogyna*
Typhaceae	*Typha angustifolia*

Table 2. The most frequent species occurring along the Hudiara drain (in order of decreasing frequency).

Sr. No.	Scientific name	No. of quadrats	Frequency %
1.	*Cynodon dactylon*	63	63.63
2.	*Parthenium hysterophorus*	48	48.48
3.	*Xanthium strumarium*	25	25.25
4.	*Desmostachya bipinnata*	25	25.25
5.	*Cyperus rotundus*	23	23.23
6.	*Calotropis procera*	18	18.18
7.	*Achyranthes aspera*	18	18.18
8.	*Suaeda fruticosa*	17	17.17
9.	*Chenopodium album*	16	16.16
10.	*Cenchrus ciliaris*	15	15.15
11.	*Salsola foetida*	13	13.13
12.	*Polygonum barbatum*	11	11.11
13.	*Amaranthus viridis*	11	11.11
14.	*Atriplex crassifolia*	11	11.11
15.	*Dichanthium annulatum*	11	11.11
16.	*Dactyloctenium aegyptium*	10	10.1
17.	*Prosopis glandulosa*	9	9.09
18.	*Mercurialis perennis*	8	8.08
19.	*Saccharum munja*	8	8.08
20.	*Ricinus communis*	8	8.08
21.	*Brachiaria ramose*	7	7.07
22.	*Alhaji marorum*	6	6.06
23.	*Panicum antidotale*	5	5.05

Community 1 was named as *Cynodon- Boerhavvia* community due to the highest cover values of *Cynodon dactylon* and *Boerhaavia diffusa* species in the area. The highest cover value of *Cynodon* verifies it a true indicator species of the wasteland (Ali *et al*., 2004) and is regarded as characteristic species of the trodden habitat (Cillers & Bredenkamp, 2000). Similarly, *Boerhavvia diffusa*, a herbaceaos plant, is widely distributed in the tropical, sub tropical and temperate regions of the world (Nasir & Rafique, 1995). It grows prostrate or ascending upward in habitats like grasslands, agriculture fields, fallow lands, wastelands and residential compounds (Singh, 2007). Community 2 includes *Parthenium hysterphorus* and *Xanthium strumarium. Parthenium histerophorus*, a fast growing species, is widely occurring in the sub continent along roadsides and wastelands (Javaid & Anjum, 2005). Whereas short stout hairy stemed *Xanthium strumarium* species of same family is usually considered a hazardous weed since it is poisonous to livestock. However, *Xanthium strumarium* has also commercial importance because of its use in medicine and yellow dye manufacturing (Everitt *et al*., 2007).

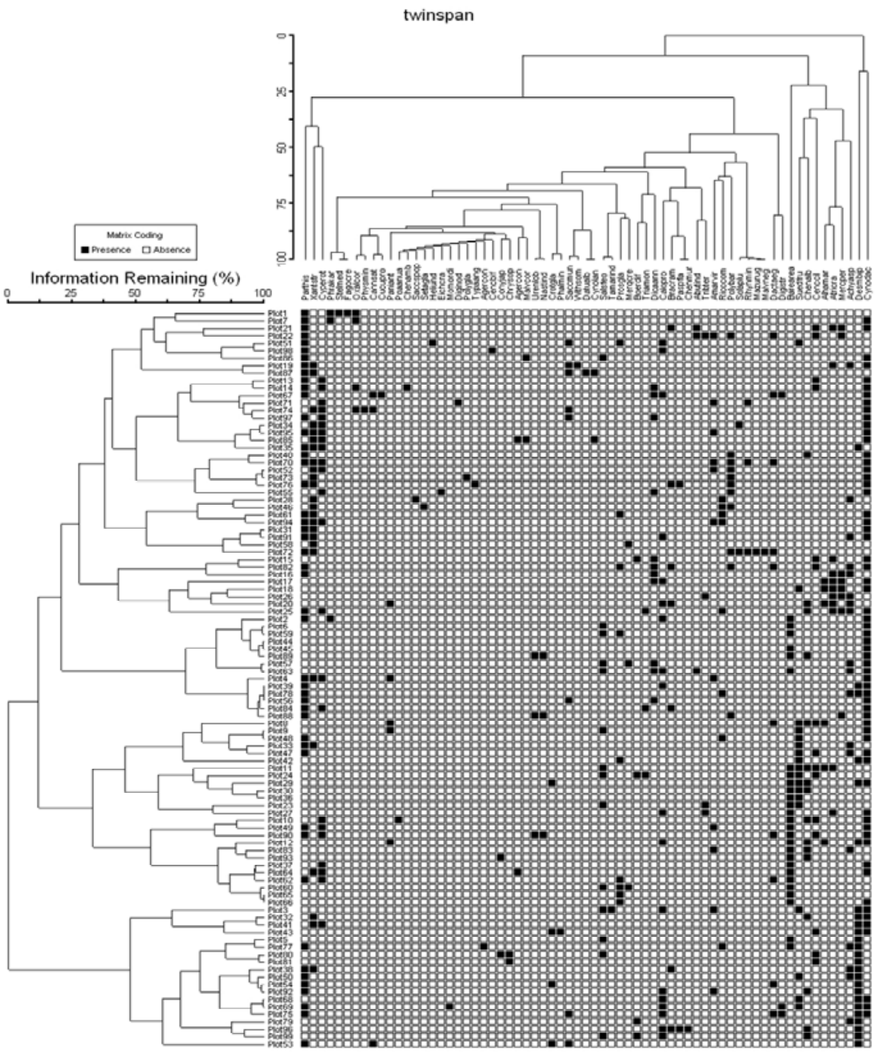

Fig. 2. Overall division of vegetation by TWINSPAN into major and minor groups.

Vegetation is a good indicator of quality of soil which affects it in every conceivable direction. Fig. 3 showed the overall distribution pattern of these species with respect to environmental variables. Point location represents individual species whereas an arrow indicated change in environmental variable, length of the arrow represents the magnitude of change. Long arrow was more closely correlated in ordination over short arrow and was much more important in influencing the community variation. Species located near to the tip of the arrows were strongly correlated and influenced by the edaphic factor while those plant species located at opposite end were less affected. The distance between the points on the graph were on approximation to their degree of similarity in terms of distribution within the quadrat. Thus two species occurring with exactly the same abundance on the same quadrat occupy the same point.

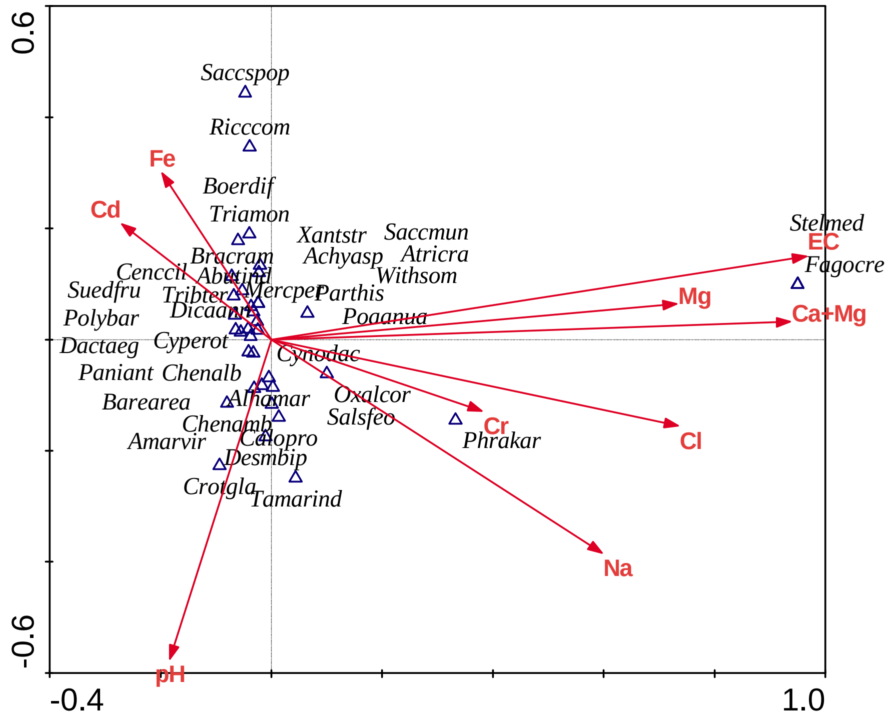

Fig. 3. Biplot diagram of species environmental variables as demarked by CCA.

The distribution of species with reference to environmental variables indicates that although most of variables are strongly correlated, but they are failed to play a major role in the grouping together of species. Most of the species were grouped in the centre of biplot diagram. Soil EC seemed to portray some role in grouping together of *Stellaria media* and *Fagonia cretica* as these species were more closely associated in diagram. Whereas *Riccinus communis* and *Boerhaavia diffusa* showed a correlation with Fe but belonging to area different families and different life forms showing a non significant correlation. Similarly, chromium although not showing strong correlation with axis 2, but *Phragmites karka* was found associated with it indicating the suitability of the species for the purpose of phytoremediation of chromium contaminated sites (Chandra *et al*., 1997).

In the present study, considerable variations in grouping of plant species were observed from place to place, the presence of group of species, which are typical species of different communities, complicates the situation. Similar difficulties were experienced by Ullmann & Heindle (1989) in Europe. Seeds germination is reduced due to the toxicity of industrial waste. Each species has its own physical and chemical requirements and species abundance is affected by industrial waste (Uzair *et al*., 2009). However, there was a general consensus that high soil fertility increases dominance of competitive and productive species, which leads to a decline in species diversity. Thus, the soil-vegetation relationship found along the Hudiara drain indicated a non significant role of metals in the grouping of species and the major groups of vegetation were assemblage of wasteland.

Acknowledgement

The authors would like to acknowledge the Higher Education Commission of Pakistan for providing financial assistance to conduct this research.

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(Received for publication 1 April 2009)