

DESCRIPTION OF COMMUNITY TYPES FROM DIFFERENT HABITATS AROUND KARACHI, PAKISTAN

FARIHA NAZ¹, MOINUDDIN AHMED¹ AND MUHAMMAD FAHEEM SIDDIQUI²

¹Dr. Moinuddin Ahmed Research Laboratory of Dendrochronology and Plant Ecology, Department of Botany, Federal Urdu University of Arts, Science and Technology, Gulshan-e-Iqbal Campus, Karachi, Pakistan

²Department of Botany, University of Karachi, Karachi 75270, Pakistan

*Corresponding author's email: mfsiddiqui@uok.edu.pk; farihakhan_08@hotmail.com

Abstract

Phytosociological sampling was conducted at six different habitats around Karachi using quadrat method. On the basis of floristic composition and dominant species, 17 community types were recognized. Maximum water holding capacity, organic matters, CaCO₃, pH, TDS, salinity and conductivity of soils belong to each stand were determined. Each habitat showed different values of water holding capacity, salinity and CaCO₃. Highest (44%) water holding capacity, organic matter (9%) and salinity (8.23ppm) was recorded from Tidal zone with gradual decrease in saline waterlogged area, alluvial plain to rocky plain. Highest amount of CaCO₃ was recorded from rocky area. It is shown that alluvial plain to dry stream similar floristic composition i.e. *Euphorbia caducifolia*- *Commiphora wightii*- *Prosopis juliflora*, with *Capparis decidua*, *Ziziphus nummularia* were recorded in many sites. Stands belonged to different habitats were clearly separated out on two dimensional Bray-Curtis stand ordination. All the three ordination axes showed significant correlations with many edaphic factors. Salinity and electrical conductivity showed highly significant correlation with axes 1 and 3. Once widely distributed climatic climax species *Prosopis cineraria* was recorded in a few places with low Importance value index. It is concluded that due to anthropogenic disturbances and aggressive growth of *Prosopis juliflora*, natural vegetation has altered considerably.

Key words: Community description, Different habitats, Stands ordination, Role of soil variables, Vegetation of Karachi.

Introduction

Karachi is a 10th largest city of the world. Since 1947 its population, area and developmental work are rapidly increasing without proper management. Its habitats may be divided in tidal area, waterlogged/ saline area, sand dunes, alluvial plains, calcareous hills and dry stream beds. Each area was characterized by particular plant species, floristic composition and communities.

Vegetation of Karachi was described by various workers focusing on a particular habitat or different habitats. Vegetation of Karachi University Campus (alluvial) was analyzed by Qadir *et al.*, (1966); Iqbal & Shafiq (1996), while vegetation of calcareous hills was explored by Shaukat (1968). Sand dunes vegetation was described by Hamidul (1970) while Karim (1970) studied coastal swamps. Ahmed (1973) and Ahmed *et al.*, (1978) studied alluvial plain, waterlogged and saline area in their vegetation analysis. Iqbal *et al.*, (1983) studied certain disturbed polluted industrial areas around Karachi. Khan *et al.*, (1987b) and Khan & Ahmad (1992) found *Prosopis juliflora* as a widely distributed species along the coastal areas of Sindh and Balochistan. Nazim *et al.*, (2010) and Nazim (2011) analyzed tidal vegetation along the coastal areas of Sindh. According to Iqbal *et al.*, (2008) natural vegetation is being replaced by anthropogenically disturbed vegetation and due to the invasion of alien species. The vegetation, floristic composition and their relative or absolute values (frequency, density, cover, importance value, stand density and stand basal area) of different habitats are gradually or rapidly altering by anthropogenic disturbances (Naz *et al.*, 2017). Ahmed (1973) reported some species which appeared after disturbance and called indicator species of disturbances. Khan *et al.*, (1987a) called them Ruderal species. Due to disturbances in a wider habitat, a new micro habitat may

be created due to increase in moisture or change in edaphic factors, resulting in elimination of natural plants and give chance to other plants which were not the characteristic plants of the previous undisturbed habitat. Beside anthropogenic disturbances, natural disaster may also change the part or the whole sequence of the vegetation. Possible future trends of the vegetation of Karachi were estimated by Iqbal & Hussain (1994).

Phytosociological analyses describe the present status and future trends of the vegetation. Applying these techniques after a passage of time not only provide information about successional changing but also changes that occurred qualitatively/quantitatively in vegetation or species level in a particular area or habitat. In alluvial plain of Karachi, a widely distributed, climatic climax species, *Prosopis cineraria* is almost replaced by an aggressively grown alien species *Prosopis juliflora*. It has changed the micro climatic conditions of alluvial, sand dunes, waterlogged saline and calcareous habitats around Karachi. Bearing these points in mind present investigation was conducted to describe current status of community types from different habitats of Karachi.

Materials and Methods

Phytosociological sampling (Ahmed & Shaukat, 2012) was carried out at 30 different sites, covering six main habitats i.e. 1) tidal area 2) waterlogged and saline area 3) sand dune 4) alluvial plain 5) rocky area and 6) dry stream. Importance value index (Curtis & McIntosh, 1951) was calculated for each stand. Quantitative description of each stand was described in a previous paper (Naz *et al.*, 2017). In this paper stands with similar leading dominant species and similar floristic composition of a particular habitat were pooled together to form a community type. In this manner 17 community types were recognized at the habitats sampled locations. Two dimensional ordination

(Bray-Curtis, 1957) was constructed to separate habitat gradient on two axes. Soils from upper (6") and lower (10") surface from each stand were obtained randomly, brought to the laboratory and sieved using 2 mm sieve. Soils of each stand were pooled together to obtain composite soil samples of each stand. Maximum water holding capacity (MWHC) was obtained using Keen's (1937) method, soil organic matter by Dean (1974) and for CaCO₃, Qadir *et al.*, (1966) technique was followed. Salinity, pH, total dissolved solids (TDS) and conductivity were determined using HANNA Multi Parameter (Model HI 9828).

Results and Discussion

Details of 30 stands and their quantitative description were explained by Naz *et al.*, (2017). Various community types belonged to each habitat with their soil characteristics are shown in Table 1. Community types were based on the presence of 1st three dominant species regardless of their leading position are described. In each habitat, stands with similar floristic composition of these dominant species (on the basis of IVI) were pooled together. Position of dominance was not considered since due to anthropogenic disturbances it was hard to determine that present 1st leading species is the actual 1st leading species and is not due to cutting of other plants in this stand or site. Total 17 community types were recognized on the basis of above mentioned method along with their soil characteristics. Two dimensional stand ordination (Bray-Curtis, 1957) was performed using density ha⁻¹ of species, basal area m² ha⁻¹ and importance value index, however density ha⁻¹ data separate most of the habitats, therefore ignoring others only ordination with density data is presented in this paper (Fig. 1). Correlation coefficient between 3 Bray-Curtis ordination axes with stands density ha⁻¹, basal area m² ha⁻¹ and soil variables are presented in Table 2. Description of these habitat types and their community types with their soil characteristics are as follows.

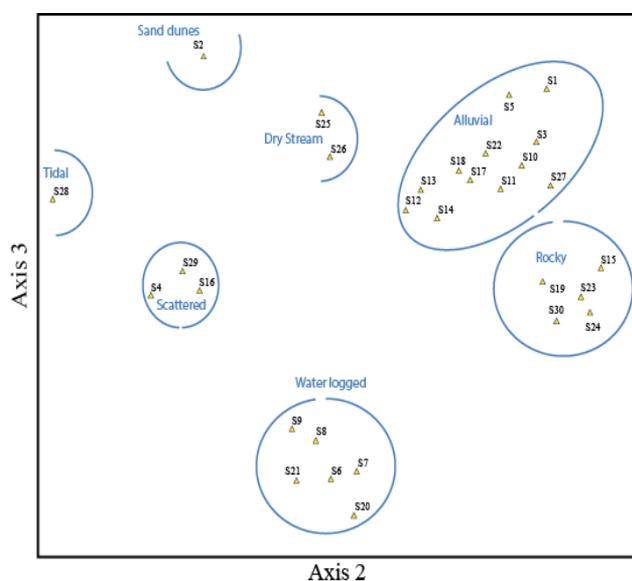


Fig. 1. Two dimensional Bray-Curtis stand ordination of study area using density⁻¹ of species.

Tidal area: This area was characterized by highest amount of organic matter (9.3%), highest (44%) maximum water holding capacity, salinity (8.23ppm), conductivity (6150 μ s/cm) and lowest amount (7%) of CaCO₃ (Table 1).

Pure stands of *Avicennia marina*: Pure stand of *Avicennia marina* was sampled in tidal zone (stand 28) of Karachi, such pure stands of *A. marina* were first described by Saifullah *et al.*, (1994). In other areas some other mangrove plants were associated with this species with low IVI. Nazim (2011) and Nazim *et al.*, (2010) reported *Avicennia marina*, *Rhizophora mucronata*, *Ceriops tagal* (spurred mangrove) and *Aegiceras corniculatum* from Sands pits. On Chashma Island nearby Rehri Island two individuals of two mangrove species i.e. *Aegiceras corniculatum* (commonly known as Black Mangrove, River Mangrove or Khalsi) and *Halostachys belangerana* (Moq.) Botsch were also seen by Dr. D. Khan (personal communication). These plants grow in unique habitat where except mangrove species no other plant can survive with the exception of *Prosopis juliflora*. This aggressive species though not recorded from inside tidal area, a few plants may be seen competing with *Avicennia marina* in some areas along the bank of tidal zone. Iqbal *et al.*, (2008) mentioned various halophytic species i.e. *Cressa cretica*, *Suaeda fruticosa* and *Salsola imbricata* associated with *Avicennia marina* but their sampling sites would be outside the tidal zone. This unique ecosystem occupied middle position of terrestrial and marine ecosystem, receiving some food from terrestrial ecosystem to provide marine ecosystem.

Waterlogged and saline areas: Table 1 showed that this area was characterized by highest amount (3738.87 \pm 707.5 ppm) of TDS, maximum water holding capacity (39%), organic matter (4.75 \pm 0.31%), salinity 4.04 \pm 0.89ppm), conductivity (4942.5 \pm 1224.79 ppm) with the exception of tidal area. Soils of the sampling area show slightly acidic (6.80 \pm 0.09) pH while Nazim (2011) and Nazim *et al.*, (2010) recorded 8.05 \pm 0.35 pH from this area. Ahmed (1973) and Ahmed *et al.*, (1978) sampled this habitat and observed pure stands of *Tamarix indica* and *Suaeda monoica*. In addition *Typha - Lemna*; *Tamarix - Cressa*; *Heliotropium - Senna* associations were also reported by them from this habitat without *Prosopis juliflora*. Five community types were observed in this habitat.

***Urochondra -Haloxylon -Suaeda monoica* community type:** This type of floristic composition was recorded from stand 6,7,20 and 21. These stands were located along the coastal area with slight sloppy or flat surface. In these stands range of salinity was from 1.58 ppm to 7.33 ppm. Almost pure stand of *Urochondra* were recognized from stand 21 with highest (7.33ppm) salinity level. In this stand a small sized *Prosopis juliflora* was competing with dominant species. In stand no. 6 *Haloxylon stocksii* while in stand 20 *Suaeda monoica* was the first leading dominant. *Suaeda fruticosa*, *Arthrocnemum indicum*, *Heliotropium crispum* were the associated species of this community type. These communities receiving pollutant discharge from nearby industries of Port Bin Qasim. Presence of *Prosopis juliflora* in this community shows that it can tolerate high amount of salinity. Pure stand of *Suaeda monoica* was also reported by Ahmed (1973) and Ahmed *et al.*, (1978) from saline area of Karachi, now it is multispecific stand in many places.

Table 1. Summary of soil analysis based on habitat and community type.

Sr. Nos.	Habitat/ Community types	Stand Nos.	MWHC (%)	Soil organic matter (%)	CaCO ₃	Salinity (ppm)	pH	TDS (ppm)	Conductivity (ppm)
A. Tidal zone									
1-	<i>Avicenia marina</i>	28	44	9.3	7	8.23	8.1	3188	6150
B. Waterlogged and saline area									
2-	<i>Urochondra-Haloxylon-Suaeda monaica</i>	6, 7, 20, 21	40	4.75	12.5	5.295	6.66	4309	5928
3-	<i>Tamarix-Cressa - Desmostachya</i>	8	30	5	24	1.53	6.7	1463	2922
4-	<i>Salsola-Heliotropium-Aerva</i>	29	45	4	13	2.73	6.94	2520	5063
5-	<i>Phragmites-Aeluropus-Typha</i>	9	39	4	26	1.3	7.43	2324	6570
6-	<i>Salvadora-Tamarix-Prosopis</i>	16	37	6	18	5.58	6.76	6367	1274
		Mean ± SE	38.2 ± 2.437	4.75 ± 0.371	18.7 ± 2.764	3.287 ± 0.912	6.898 ± 0.141	3397 ± 875	4351 ± 986
C. Sand dunes									
7-	<i>Aerovpseu- Heli.cris-Blep.sind</i>	2	15	2	11	0.13	8.62	132	266
D. Alluvial plain									
8-	<i>Capparis -Euphorbia-Commiphora</i>	13, 22	22	2.333	20.33	0.147	7.24	137.7	275
9-	<i>Capparis - Commiphora-Prosopis</i>	27	22	5	15	0.17	7.12	181	360
10-	<i>Commiphora-Prosopis j.-Prosopis c.</i>	14,17	19.5	5.5	16	0.305	7.8	283.5	580
11-	<i>Ziziphus- Prosopis - Calatropis</i>	11	14	1	29	0.12	7.45	129	258
12-	<i>Prosopis - Capparis - Commiphora</i>	1,3, 5, 10,12, 18	22.4	4.6	17.6	0.226	7.58	237	477
		Mean ± SE	19.98 ± 1.582	3.687 ± 0.863	19.586 ± 2.52	0.194 ± 0.033	7.438 ± 0.121	194 ± 29.5	390 ± 61.33
E. Rocky plain									
13-	<i>Euphorbia-Commiphora - Prosopis</i>	15,19,23,24	19	5.25	22.75	0.1925	7.32	195	370
14-	<i>Capparis - Grewia - Prosopis</i>	4	18	1.00	23	0.16	7.94	170	340
15-	<i>Prosopis - Ziziphus- Calatropis</i>	30	20	7.0	22	0.12	7.55	190	290
		Mean ± SE	19 ± 0.577	4.422 ± 1.781	22.583 ± 0.301	0.158 ± 0.021	7.603 ± 0.181	185 ± 7.638	333.33 ± 23.33
F. Dry stream									
16-	<i>Salv. pers-Tama. indi-Halo.stoc</i>	25	22	6	11	0.17	7.34	180	225
17-	<i>Euph.cadu- Pros.juli- Pros.cine</i>	26	21	6	8	0.22	7.47	230	430
		Mean ± SE	21.5 ± 0.5	6.0 ± 0.0	9.5 ± 1.5	0.195 ± 0.025	7.405 ± 0.065	205 ± 25	328 ± 102.5

Key to abbreviations: MWHC = maximum water holding capacity, TDS = total dissolved solids

Tamarix- Cressa- Desmostachya community type: This type of floristic composition with different relative and importance values were recorded near Malir (stand 8). This site used to be a dry alluvial plain but due to poor drainage system, this area was converted into waterlogged and saline area and natural vegetation was completely altered. Salinity was 1.53 ppm (Table 1). In this community type *Salvadora persica* become 7th leading dominant while *Prosopis juliflora* may be seen as sixth dominant species. Associated species of this community type were *Haloxylon stocksii*, *Suaeda fruticosa*, *Salvadora persica* and *Aeluropus lagopoides*. This type of community was reported by Ahmed (1973) from Shujaabad. Recently all plants were removed for a developing project. Only 8 species were recorded in this stand.

Salsola- Heliotropium – Aerva community type: This highly disturbed community type was located near WWF Office (stand 29) Hawksbay coastal area. Highest water holding capacity (45%) with moderate (2.73 ppm) salinity was recorded from this area. *Halopyrum mucronatum*, *Fagonia indica*, few seedlings of *Avicennia marina*, *Ipomoea alba*, *Cyperus rotundus* where the other associates. This type of community type was reported by Ahmed (1973) from Manghopir area. In this community *Arthrocnemum indicum*, *Zaleya pentandra*, *Atriplex stocksii* and *Crotalaria prostrata* may be seen in low number.

Phragmites – Aeluropus –Typha community type: This site also used to be alluvial plain but sweet water released by Steel Mill of Port Qasim completely altered the vegetation composition. From same location *Tamarix-Typha* community was recorded by Ahmed (1973) while now vegetation composition is changed. Highest amount (26%) of CaCO_3 and pH (7.43) was recorded in this soil. Important associates of this community (stand 9) were *Tamarix indica*, *Salvadora persica*, *Avicennia marina*, *Haloxylon stocksii*, *Suaeda fruticosa* and a few *Prosopis juliflora* along the bank of this pond. Recently this community type was completely eradicated for a new power plant. Few more plants with low in number were also distributed in this community type i.e. *Suaeda monoica*, *Launea procumbens*, *Lemna aequinoctialis*, *Aeluropus lagopoides* and *Cyperus rotundus*.

Salvadora – Tamarix – Prosopis juliflora community type: This community type was recorded near Airport (stand 16); showing higher (5.58ppm) salinity, eighteen percent CaCO_3 and higher (6%) organic matter. This area also supposed to be alluvial plain but due to poor drainage system, converted in waterlogged and saline, hence vegetation was completely altered. *Salvadora persica*, was the leading dominant species. *Vachellia nilotica*, *Suaeda fruticosa*, *Salsola imbricata*, *Cressa cretica* and *Limonium stocksii* were the associated plants of this community. *Salvadora oleoides* and *Ziziphus nummularia* were representing the original plants of the area like *Tamarix-Cressa-Desmostachya* community type; this community is recently eradicated for airport developing

projects. Only eleven plant species were recorded in this area. This type of community was also recorded in dry stream nala (stand 25).

C. Sand dune: Small sand dunes are widely distributed near coastal area and slightly inner areas of Sindh. Most of the sand dunes in Port Qasim area were covered with *Prosopis juliflora*, however on some sand dunes these *Prosopis juliflora* were logged for fuel purpose. Therefore other herbaceous plants and small shrubs start growing. pH of this sand dune was considerably higher (8.62) while TDS and conductivity were lower compared to above mentioned habitat.

Aerva- Heliotropium- Blepharis community type: *Aerva pseudotomentosa*, *Heliotropium crispum* and *Blepharis sindica* community type was distributed on a small and highly disturbed sand dune near Port Qasim (Stand 2). *Cordia gharaf*, *Tribulus terrestris*, *Convolvulus prostratus*, *Lycium edgeworthii* and a few Juvenile *Prosopis juliflora* were the associates of this community type. A total of 18 plant species were recorded from this site. Other species were *Blepharis sindica*, *Fagon iaindica*, *Cleome brachycarpa*, *Abutilon indicum*, *Calotropis procera*, *Indigofera cordifolia*, *Citrullus colocynthis*, *Cucumis prophetarum*, *Zygophyllum simplex* and *Capparis decidua*.

D. Alluvial Plain: In this habitat maximum water holding capacity ($21.08 \pm 0.62\%$), amount of organic matter ($3.91 \pm 0.6\%$), salinity ($0.205 \pm 0.02\text{ppm}$), TDS (206.33 ± 24.50) and conductivity (415.66 ± 50.17) were considerably low while amount of CaCO_3 ($18.75 \pm 1.62\%$) was higher. This type of habitat is widely distributed in and around Karachi. Four community types were recognized in this habitat. Iqbal & Shafiq (1996) studied plant communities of alluvial areas of Karachi University. Our values of soil were within the range of their study. *Euphorbia –Ziziphus*, *Prosopis cineraria –Euphorbia–Commiphora* associations were recorded by Ahmed (1973) and Ahmed et al., (1978) from alluvial plain of Karachi. According to them out of 13 stands, 7 stands were dominated by *Prosopis cineraria – Euphorbia* association.

Capparis- Euphorbia- Commiphora community type: It was observed that due to cutting of above mentioned native species for fuel or development purposes, quantitative values, their leading positions and floristic composition of species were altered. Therefore, *Prosopis juliflora* appeared as first (stand 1, 5) and second (stand 13, 22) dominant. *Fagonia indica* also appeared as 2nd and 3rd dominant species showing degree of disturbance. From these areas Ahmed (1973) also reported *Capparis- Euphorbia- Commiphora* community without indication of disturbed area species. In this community type maximum water holding capacity ranged 17 to 29%, organic matter 1 to 6 % and amount of CaCO_3 ranged 10 to 22 %. In one location due to change in local habitat *Suaeda fruticosa* may be seen as a dominant species (stand 13).

Lycium edgeworthii, *Aerva pseudotomentosa*, *Cordia gharaf*, *Heliotropium crispum* and *Salsola imbricata* were the associated species of this community type. *Senna holosericea*, *Calotropis procera*, *Tribulus terrestris*, *Blepharis sindica*, *Cucumis prophetarum*, *Maerua arenaria*, *Aerva javanica*, *Haloxylon stocksii* and *Cleome viscosa* were also distributed in this community type.

Euphorbia- Commiphora- Prosopis community type:

This community was recorded at stand 27. It seems that *Capparis* or *Ziziphus* species were replaced by local people and *Prosopis juliflora* has entered. A climatic climax species *Prosopis cineraria* was also present in scattered form. This small tree species was widely used by locals for fuel purpose. This was the dominating species of this area but now hardly found in some areas. Ahmed (1973) reported *Prosopis cineraria*- *Euphorbia* – *Commiphora* community at many places of Dhabeji area. *Leptadenia pyrotechnica*, *Senna holosericea*, *Grewia tenax* and *Fagonia indica* were the associated species of this community type. Soil properties of this site were in the range of other community types of this habitat. Sixteen species were recorded in this site. This community type also supported *Abutilon indicum*, *Atriplex griffithii*, *Convolvulus rhyniospermus*, *Cleome brachycarpa*, *Aeluropus lagopoides*, *Lycium edgeworthii*, *Barleria acanthoides* and *Indigofera cordifolia*.

Commiphora- Prosopis juliflora- Prosopis cineraria community type:

Stand 14 and 17 were dominating by above first two species while in stand 14 *Prosopis cineraria* was replaced by *Salsola imbricata* due to extensive cutting of third dominated small tree species. In this area pH was 7.2 and 8.45, CaCO₃ was 17 and 14%, organic matter 5% and maximum water holding capacity was 16 and 21%. This community supported 17 species. *Capparis decidua*, *Euphorbia caducifolia*, *Grewia tenax*, *Fagonia indica*, *Abutilon indicum* and *Calotropisprocera* were associated with this community type. Other species like *Salsola imbricata*, *Senna holosericea*, *Cenchrus biflorus*, *Panicum antidotale*, *Aerva javanica*, *Cordia gharaf*, *Barleria acanthoides*, *Cadaba fruticosa*, *Lycium edgeworthii* and *Atriplex griffithii* were also recorded from this community type with low values.

Ziziphus –Prosopis- Calotropis community type:

This highly disturbed site (stand 11) showed low (1%) organic matter, highest CaCO₃ (29%), low (0.12 ppm) salinity and higher (7.45) pH. Above mentioned 2nd and 3rd dominant species were indicator of disturbances, according to Ahmed (1973) and Ahmed and Shaukat (2012). In this stand presence of *Euphorbia caducifolia*, *Capparis decidua*, *Commiphora wightii* showed that these native and characteristics species of this site were replaced by *Prosopis juliflora* and *Calotropis procera*. *Salsola imbricata*, *Senna holosericea*, *Aerva javanica*, *Zygophyllum simplex*, *Fagonia indica*, *Blepharis sindica* were the associated species. Among 22 different plant species 1st three dominant species of this community type were also recorded at rocky surface. *Cressa cretica*, *Atriplex griffithii*, *Cenchrus biflorus*, *Cadaba fruticosa*, *Blepharis sindica*, *Indigofera cordifolia*, *Pulicaria*

carnosa, *Barleria acanthoides* were also distributed with low importance values.

Prosopis – Capparis- Commiphora community type:

This community type was recorded from stand no 1,3,5,10,12 and 18. Eight to 23 species were recorded in these sites. Due to the presence of *Prosopis juliflora* as leading dominant species, this community type was considered highly disturbed. In this area *Euphorbia caducifolia* used to be a 1st leading dominant species. Removal of this species gave chance to fast invading *Prosopis juliflora* to take its position. In these locations *Prosopis cineraria* was the leading dominant (Ahmed, 1973) now it was hardly seen even outside the sampling site. In these stands maximum water holding capacity ranged from 14% to 29%, organic matter from 1% to 6%, CaCO₃ 10 to 29% and salinity ranged from 0.1 to 0.37 ppm. In these sites due to localized change in soil *Vachellia nilotica*, *Suaeda fruticosa*, *Salsola imbricata*, *Fagonia indica* were also recorded *Euphorbia caducifolia*, *Senna holosericea*, *Ziziphus nummularia*, *Lycium edgeworthii* were also distributed with higher relative and absolute values. In addition *Blepharis sindica*, *Aerva pseudotomentosa*, *Cressa cretica*, *Tephrosia uniflora*, *Aerva javanica*, *Haloxylon stocksii*, *Heliotropium Rhus mysorensis*, *Grewia tenax*, *Calotropis procera*, *Convolvulus prostratus*, *Cordia gharaf* and *Rhusmysorensis* were also found in this community type.

E. Rocky plain: These soils show highest (22.66 ± 1.38%) amount of CaCO₃, almost similar (7.46 ± 0.14) pH, lowest (189.83 ± 15.50) TDS and lowest (19 ± 0.73%) water holding capacity, in compare to sand dune and alluvial areas. Vegetation dynamics and various successional stages on calcareous hills around Karachi were presented by Shaukat *et al.*, (1981), which were hardly recognized now due to anthropogenic disturbance.

Euphorbia – Commiphora –Prosopis community type:

This community type was distributed at stand 15, 19, 23 and 24. At stand 24 this arrangement of dominant positions of species was altered by *Commiphora* – *Capparis- Euphorbia*. It is likely that some places *Capparis decidua* was completely replaced by *Prosopis juliflora* after cutting of *Capparis deciduas*, since this species and *Prosopis cineraria* occupying 3rd dominant position in some stands. In these sites 8 to 25 species were recorded. According to Shaukat *et al.*, (1981), *Euphorbia*, *Grewia* species and *Commiphora* were the species of intermediate succession on calcareous rocks or surface. *Euphorbia* –*Commiphora* association was also recorded by Ahmed (1973) and Ahmed *et al.*, (1978) in these areas without *Prosopis juliflora*. *Lycium edgeworthii*, *Cressa cretica*, *Fagonia indica*, *Cleome viscosa*, *Salvia santolinifolia*, *Boerhavia verticillata* and *Grewia tenax* were the associated species of this community type. This community type also contains *Pulicaria carnosa*, *Barleria acanthoides*, *Ziziphus nummularia*, *Atriplex stocksii*, *Convolvulus glomeratus*, *Cordia gharaf*, *Capparis decidua* and *Zygophyllum simplex*. It seems that whole sequence of succession is changed due to disturbances.

Capparis- Grewia- Ziziphus community type: Eighteen percent maximum water holding capacity, lowest (1%) organic matter, higher (23%) amount of CaCO_3 and 7.94 pH was recorded from (stand 4) this site. Sixteen species were distributed in this stand. *Tephrosia uniflora*, *Indigofera cordifolia*, *Cordia gharaf*, *Arthrocnemum indicum* and indicator of disturbance *Aerva pseudotomentosa*, *Senna holosericea*, *Calotropis procera*, *Cressa cretica* and *Prosopis juliflora* were recorded from this stand. Species like *Grewia tenax*, *Convolvulus glomeratus*, *Corchorus depressus*, *Ziziphus nummularia*, *Sida ovata* were also a part of this community type.

Prosopis – Ziziphus- Calotropis community type: Widely distributed native plants were replaced by *Prosopis juliflora* and *Calotropis procera* indicating highly disturbed condition of this (30) stand. This community type show highest (20%) maximum water holding capacity, lowest (0.12%) salinity, higher (7%) amount of organic matter, 22% CaCO_3 and 7.55 pH. Dominant species of this community type was also found at alluvial plain. This site supported *Atriplex griffithii* and indicator species of disturbed condition i.e. *Senna holosericea*, *Heliotropium ophioglossum*, *Haloxylon stocksii*, *Abutilon indicum* and *Aerva javanica*. *Prosopis juliflora* – *Calotropis procera* with *Salvadora* community was also recorded by Iqbal *et al.*, (2008). Total 16 species were recorded in this community type. Habitat of this site also supported species like *Corchorus depressus*, *Salsola imbricata*, *Fagonia indica*, *Launea procumbens*, *Indigofera oblongifolia* and *Tribulus terrestris*.

F. Dry Stream: Sites 25 and 26 were belonged to dry stream (Nala) showing rocky surface. Two types of community types were recorded which may also be seen on alluvial and rocky areas. Maximum water holding capacity was $21.5 \pm 0.5\%$ and organic matter 6 percent were higher than alluvial and rocky areas while 7.4 ± 0.06 pH and $9.5 \pm 1.5\%$ CaCO_3 were lower than above mentioned three habitats. Cutting of plants for fuel purpose and over grazing were in practice in these nalas from local people.

Salvadora – Tamarix- Haloxylon community type: *Salvadora persica*, *Tamarix indica* and *Haloxylon stocksii* were dominated in dry stream bed (stand 25) where water is available. Water holding capacity was slightly higher (22%) than some rocky, alluvial and sand dune. Amount of organic matter was also higher while CaCO_3 (11%) was lower than above mentioned habitats. pH was almost similar to alluvial and rocky sites. Thirteen species were recorded in this community type. *Senna holosericea*, *Azadirachta indica*, *Calotropis procera*, *Boerhavia verticillata*, *Sporobolus arabicus* and *Grewia tenax* were the associated plants of this community type. Similar floristic composition was also recorded from other waterlogged and saline areas. *Cleome brachycarpa*, *Fagonia indica*, *Sida ovata* and *Zygophyllum simplex* were also recorded with low values.

Euphorbia – Prosopis juliflora- Prosopis cineraria community type: This dry stream was drier than previous nala. Floristic composition and importance values of native species were altered due to cutting of *Prosopis cineraria* and entering *Prosopis juliflora*. Accumulated soil of this nala show slightly higher maximum water holding capacity, higher (6%) organic matter and lowest (8%) amount of CaCO_3 . Associated species of this community type (stand 26) were *Barleria prionitis*, *Fagonia indica*, *Cleome brachycarpa*, *Tephrosia uniflora*, *Indigofera cordifolia* and *Sporobolus arabicus*. Other species like *Ziziphus nummularia*, *Capparis decidua*, *Prosopis glandulosa*, *Abutilon indicum*, *Calotropis procera* and *Senna holosericea*, *Zygophyllum simplex*, *Maerua arenaria*, *Citrullus colocynthis* and *Grewia tenax* were also distributed with low relative and absolute values. Similar floristic composition and dominant species were also recorded from alluvial and rocky sites.

From alluvial areas of Dhabeji, out of 13 stands, *Prosopis cineraria* was distributed as a first leading dominant species (Ahmed, 1973 and Ahmed *et al.*, 1978) now it occupied hardly 3rd dominant position in one site only due to cutting for fuel purposes.

Communities reported by Qadir *et al.*, (1966) were completely eradicated from Karachi University during construction of new departments. Iqbal and Shafiq (1966) found six communities in Karachi University Campus without previously reported native species. *Euphorbia caducifolia*, *Commiphora wightii* and *Pulicaria hookeri* the latter was reported from calcareous hills (rocky surface) by Shaukat & Qadir (1971); however these species except *P. hookeri* were also recorded from alluvial plains and dry stream beds.

Ahmed (1973); Ahmed *et al.*, (1978) sampled Dhabeji, Manghopir and saline areas around Karachi. *Typha- Launea procumbens*, *Aeluropis insignis* and *Tamarix sp.* were recorded in saline waterlogged areas. From alluvial plain they found *Euphorbia-Ziziphus*; *Prosopis cineraria-Euphorbia*; *Euphorbia-Commiphora* communities but now these communities are highly altered in their dominant positions, quantitative values and floristic compositions. Shaukat *et al.*, (1976) recognized 3 community types in Gadap area. Present soil characteristics are within the range of their investigations. Previous studies reposted that *Prosopis cineraria* was the one of the leading dominant species in 19 stand out of 22 stands, while *Prosopis juliflora* was distributed in 6 stands with low values. Now the situation has completely changed due to disturbance. Khan *et al.*, (1987b) found *Achyranthes aspera* L. dominated ruderal vegetation along with some associated species i.e. *Cenchrus biflorus*, *Leucus urticifolia* and *Rhincosia minima* at suburbs of Karachi. Iqbal *et al.*, (2008) conducted phytosociological survey around urban areas of Karachi which were highly disturbed. They recognized 15 plant communities from different habitats. *Prosopis juliflora* was 1st dominating species in 6 communities.

Stands were shown on two dimension stand ordination. Tidal group occupied the extreme left position on axis 1 and middle position of axis 2. The only one stand of sand dune grab the most upper position of the

ordination space while waterlogged group was just on extreme lower side of the ordination. Similarly rocky group attained extreme right side of axis, opposing tidal area, therefore groups were distinct. Next to rocky, alluvial and dry stream stands were closely grouped. These groups also have same outside scattered stands. This may be due to highly disturbed situation of rocky, alluvial and dry stream areas. However despite all types of disturbances ordination displayed different habitat conditions of study area.

Relationships between 3 Bray-Curtis ordination axes with the stand density ha^{-1} exhibited no correlation while the basal area showed significant correlation with all three ordination axes (Table 2). Most of the soil variables showed significant correlation with all three ordination axes, it showed the overriding role of soil characteristics on the distribution of vegetation, especially MWHC, salinity and total dissolved solids that showed significant relationships with all three axes. Ordination axes 1 showed significant correlation with all soil variables except pH.

It is recorded that due to increased population and development projects, natural vegetation is greatly altered in their floristic composition and quantitative values i.e. presence, density and cover. Many places local habitat is also changed in small area (like oasis) representing different floristic composition. It is also observed that due to anthropogenic disturbances, other species which were not the characteristic species of the particular habitat, also have a chance of propagation i.e. *Prosopis juliflora*, *Prosopis glandulosa*, *Aerva javanica*, *Aerva pseudotomentosa*, *Calotropis procera*, *Abutilon indicum*, *Senna holosericea*, *Cressa cretica*. According to Ahmed (1973) these are indicator species of disturbance. Due to above mentioned reasons a number of communities have appeared and some species are distributed beyond their habitat, showing wide ecological amplitude. Due to aggressive nature, wider ecological amplitude, salt and moisture tolerant, it is concluded that in future natural vegetation will be replaced by *Prosopis juliflora* as the dominant species in most of the habitats.

Table 2. Correlation coefficient between 3 Bray-Curtis ordination axes with stands density ha^{-1} , basal area $\text{m}^2 \text{ha}^{-1}$ and soil variables.

S. No.	Variables	Axis 1		Axis 2		Axis 3	
		r	Prob. Level	r	Prob. Level	r	Prob. Level
1.	Density ha^{-1}	0.0862	ns	0.0084	ns	0.1135	ns
2.	Basal area $\text{m}^2 \text{ha}^{-1}$	0.4823	$p < 0.01$	0.4393	$p < 0.05$	0.3416	$p < 0.5$
Soil variables							
1.	MWHC	-0.5393	$p < 0.01$	-0.3544	$p < 0.05$	-0.4107	$p < 0.05$
2.	Organic matter	-0.3482	$p < 0.05$	-0.1023	ns	-0.0215	ns
3.	CaCO_3	0.4553	$p < 0.01$	0.3325	$p < 0.05$	0.1126	ns
4.	Salinity	-0.6714	$p < 0.001$	-0.4454	$p < 0.01$	-0.5635	$p < 0.001$
5.	pH	0.0854	ns	0.0736	ns	0.2728	ns
6.	Total dissolved solids	-0.4284	$p < 0.05$	-0.3924	$p < 0.05$	-0.5615	$p < 0.001$
7.	Electrical conductivity	-0.5782	$p < 0.001$	-0.1628	ns	-0.6256	$p < 0.001$

Key to abbreviations: MWHC= Maximum water holding capacity, r = Correlation coefficient, ns = Non-significant, Prob. Level = Probability level

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